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NOVEL DESIGN OF PUMPING ENGINE

FOR DIRECT CONNECTION TO VERTICAL SHAFT SCREW PUMP

WITH THE USE OF a screw propeller pump operating on a vertical shaft comes the necessity of driving this shaft either through gearing or by means of a special connection to the prime mover. When the pump is of small size so that it is motor driven, the natural solution is to stand the motor on end and mount it directly on the pump shaft. With the larger sizes of pumps demanded for city service, however, this method of drive is not always desirable because of the size of motor required and the difficulty of up-ending it. For such a situation, the Wisconsin Engine Co., of Corliss, Wis., has designed and manufactured the special design of cross compound engine illustrated herewith.

General Arrangement

STEADINESS of operation and compactness of arrangement are secured by arranging both connecting rods to drive on the same crank pin, and by placing the cylinders at 90 deg. to each other. This gives a short shaft, a single crank pin, a convenient position for rods and eccentrics, and an even turning moment. It brings the plane of motion of the crank and connecting rods horizontal instead of vertical, and therefore introduces side strains not encountered where the

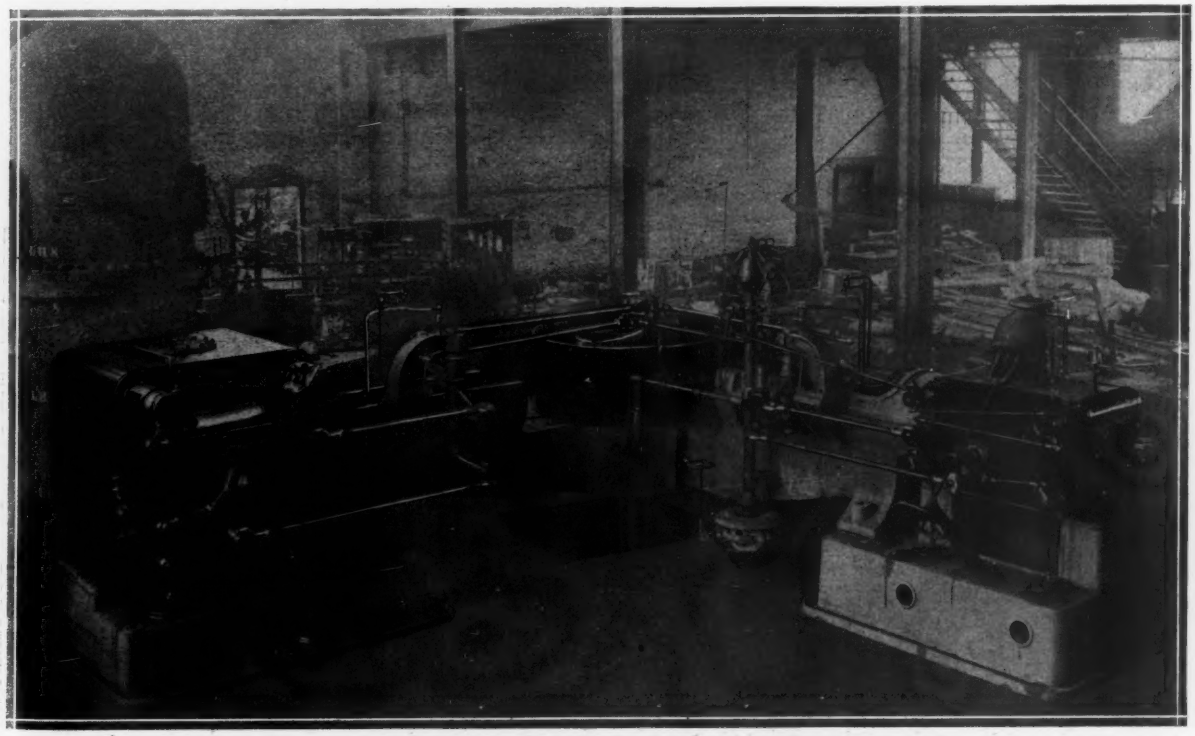


FIG. 1. FAIRVIEW PUMPING ENGINE FROM THE GEAR SIDE

main shaft is horizontal and which calls for special design of the frames and bearings. It calls also for a special arrangement of eccentric and eccentric rod connection to the valve gear, the detail of which is exceedingly interesting.

the steam valves, and in each case by a double connection the pins drive the valves for both high pressure and low pressure cylinder. The method of making this connection is clearly shown in the plan and elevation of the assembled view.

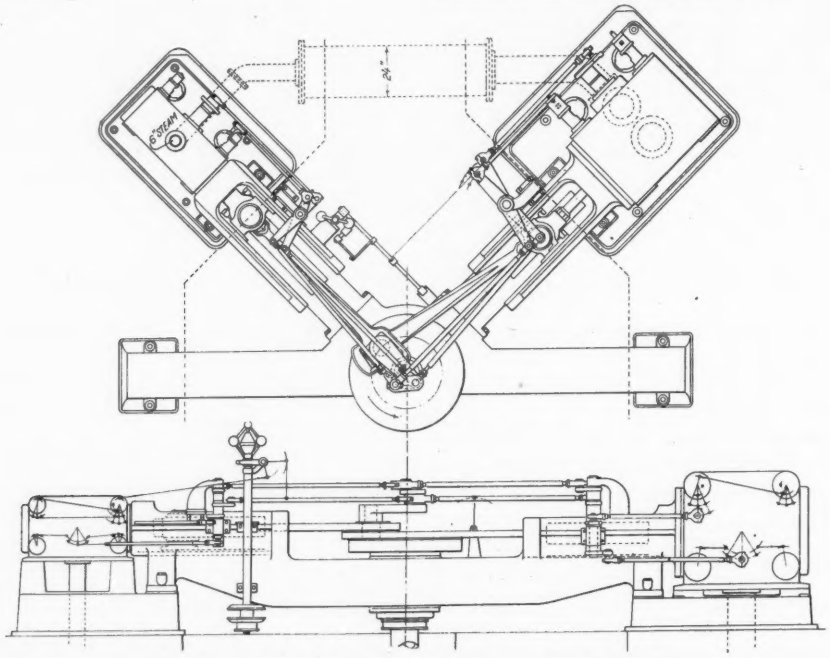


FIG. 2. PLAN AND ELEVATION OF FAIRVIEW ENGINE

Eccentrics and Rocker Arms

INSTEAD of the usual form of eccentric mounted on the main shaft, an arm is made fast to the crank pin so that it revolves with the crank, and on the end

From these pins, eccentric rods run to rocker arms which are mounted on a vertical shaft on each frame. The steam rod in each case drives a sleeve which swings freely on the shaft, while the exhaust rod

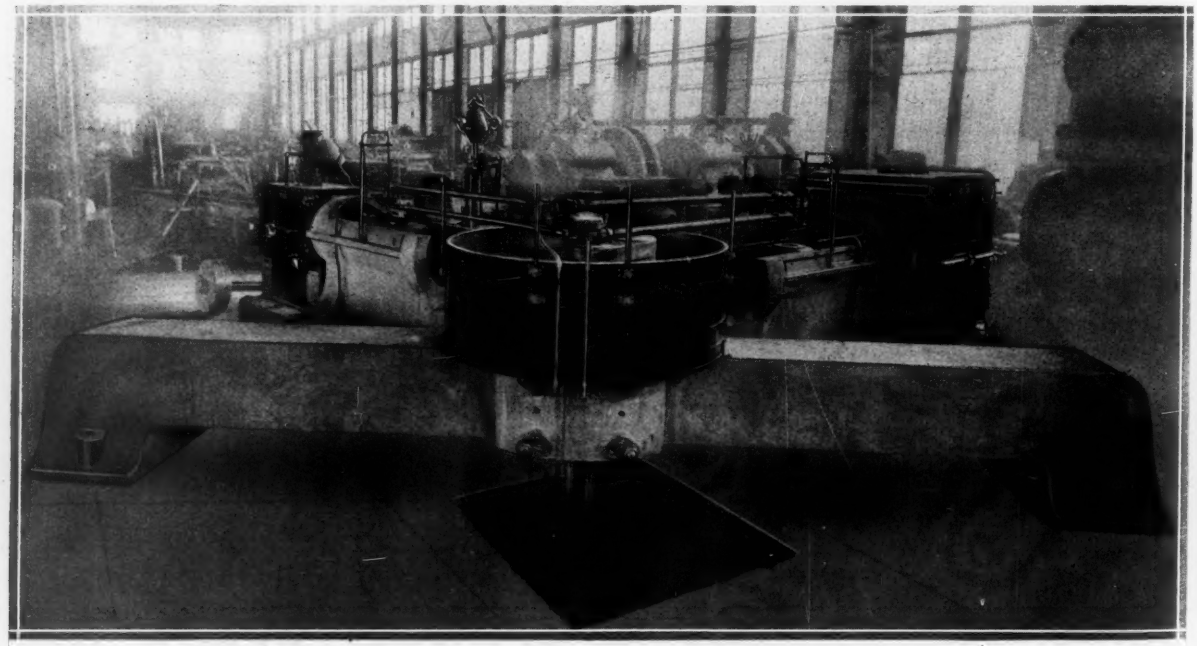


FIG. 3. SHOP VIEW OF FAIRVIEW ENGINE FROM SHAFT END

of this arm are mounted 2 pins, which drive the eccentric rods. One pin is for the exhaust, the other for

drives an arm made fast to the shaft, and therefore swings the shaft with a vibrating motion. Connection

is by means of ball and socket pins, which permit the eccentric rods to swing and turn in any direction.

Bearings for this vertical shaft are in brackets which are bolted to the engine frame, one of these being L shaped, standing on a horizontal pad, and the other being a straight arm bolted to a vertical pad.

In the case of the steam valves, a rod runs from the opposite arm of the rocker to the nearer valve

Governor Action

ONE governor controls the cutoff position for both the high and low-pressure cylinders, the connection between governor, rocker arm and high-pressure valves being direct by a knock-off rod connection running to the nearer steam valve cam and a link from that cam to the farther one; for the low-pressure cylinder the motion is transmitted through a shaft and

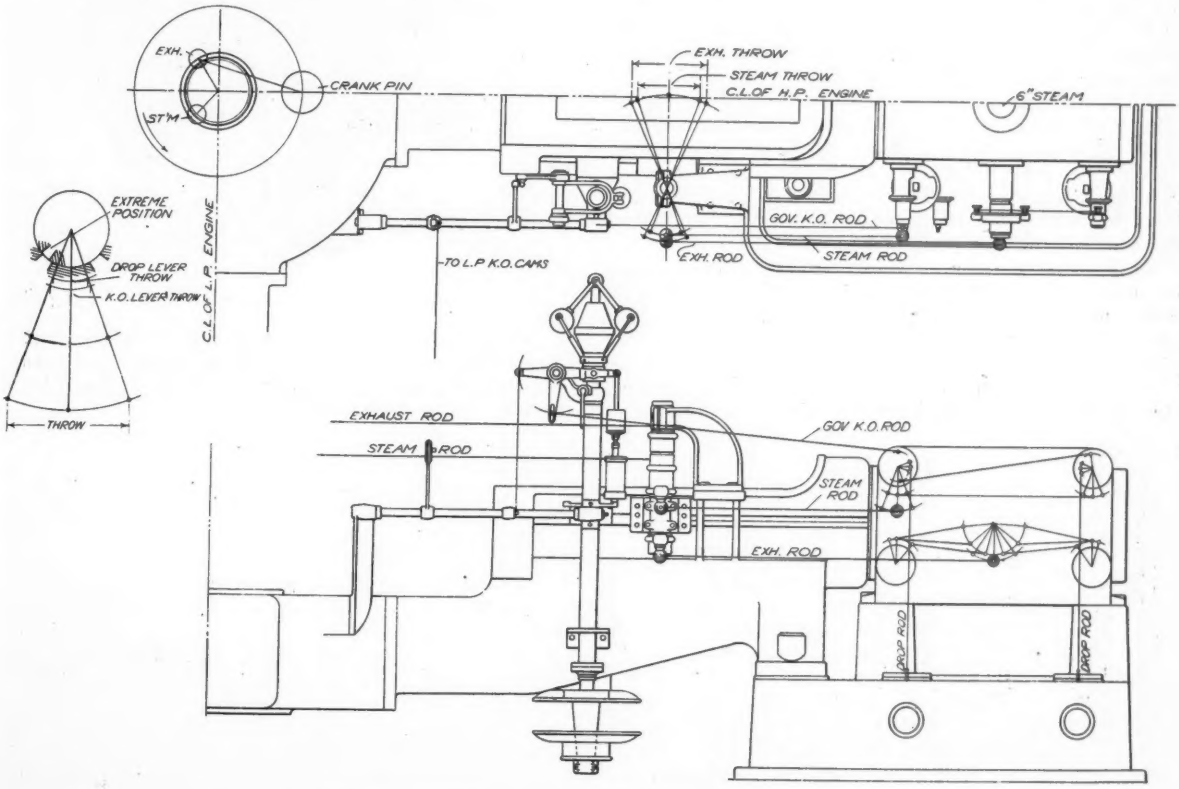


FIG. 4. HIGH-PRESSURE VALVE GEAR AND DIAGRAMS

crank, and connection from this valve crank to the farther one is made by a valve rod. In the case of the exhaust valves an arm extending from the lower end of the vertical shaft is connected to a half wrist plate which swings on a wrist plate stud, and from this plate, links lead to the exhaust valve crank pins. The

2 bell crank levers, the shaft being driven from the governor bell crank, and the second arm on the shaft giving motion to the low-pressure knock-off rod which

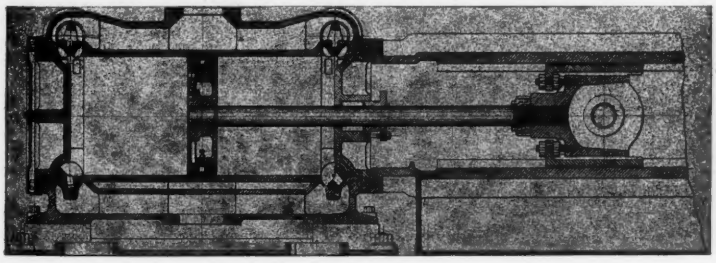


FIG. 6. SECTION OF WISCONSIN-CORLISS CYLINDER, PISTON AND VALVES

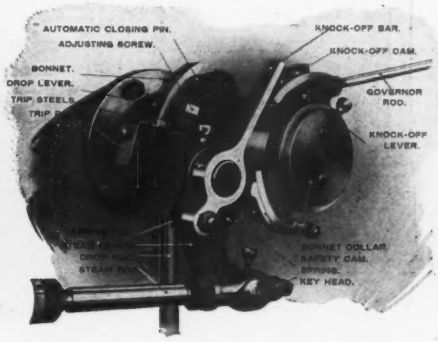


FIG. 7. VALVE GEAR AND BONNET DETAILS, FRONT VIEW

connection to exhaust valves is of course positive, while the connection to the steam valves is through a knock-off mechanism, the position of the trips being controlled by the governor.

is connected to the nearer steam valve on the low pressure cylinder.

Drive for the governor is by means of a belt from the main shaft to a vertical pulley on the lower part

of the governor stand; this pulley is attached to one disk of a variable speed friction drive, the other disk being fast to the governor spindle. This makes it possible to vary the speed of the engine simply by changing the variable speed connection to the governor.

The steam valve gear is of the regular Wisconsin type, 2 views of which are shown in the illustrations. Some of the important features of this are worthy of attention; the drop lever is rigidly attached to the middle of the valve stem and inside the bonnet opening, so that the valve stem is supported on both sides of the pull of the drop lever. Also the push of the steam lever on the trip steels is on the same side as the drop rod so that this lifting of the drop rod against the resistance of the dash pot is not transmitted across the valve stem. Rigidity is thereby obtained, also a large bearing surface of the steam lever on the bonnet is secured which gives small friction, little wear and permanent alinement.

Adjustment of the drop lever to the valve stem is by means of a split tapered sleeve and a bored taper which fits around the valve stem and drop lever. The edges of the sleeve fit snugly against the key which fits in both the stem and lever and on the end of the sleeve is a drive nut which, when tightened up, wedges the sleeve immovably between the stem and lever with its edges fitting on both sides of the key, thus locking all parts together as though they were a solid forging.

As the knockoff lever has little strain upon it, it is placed on the end of the bonnet and rides on a collar the shoulder of which bears against the steam lever, thus keeping that lever from touching the collar and interfering with the operation of the governor. The amount of contact of the trip steels is controlled by an adjusting screw which can be changed while the engine is running, so that if one of the steels becomes damaged at the edge a little more lap can be given and a shutdown avoided.

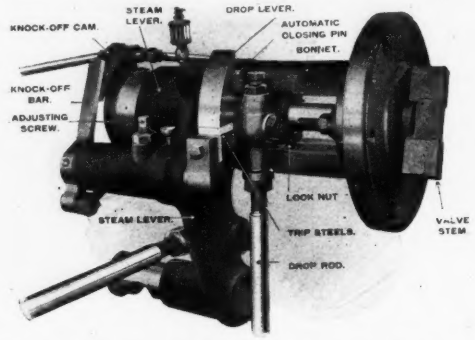


FIG. 8. BONNET AND TRIP MECHANISM FROM INNER END

If the dashpot should fail to act from any cause, an automatic closing pin positively closes the steam valve, thus preventing the engine from taking steam at both ends simultaneously.

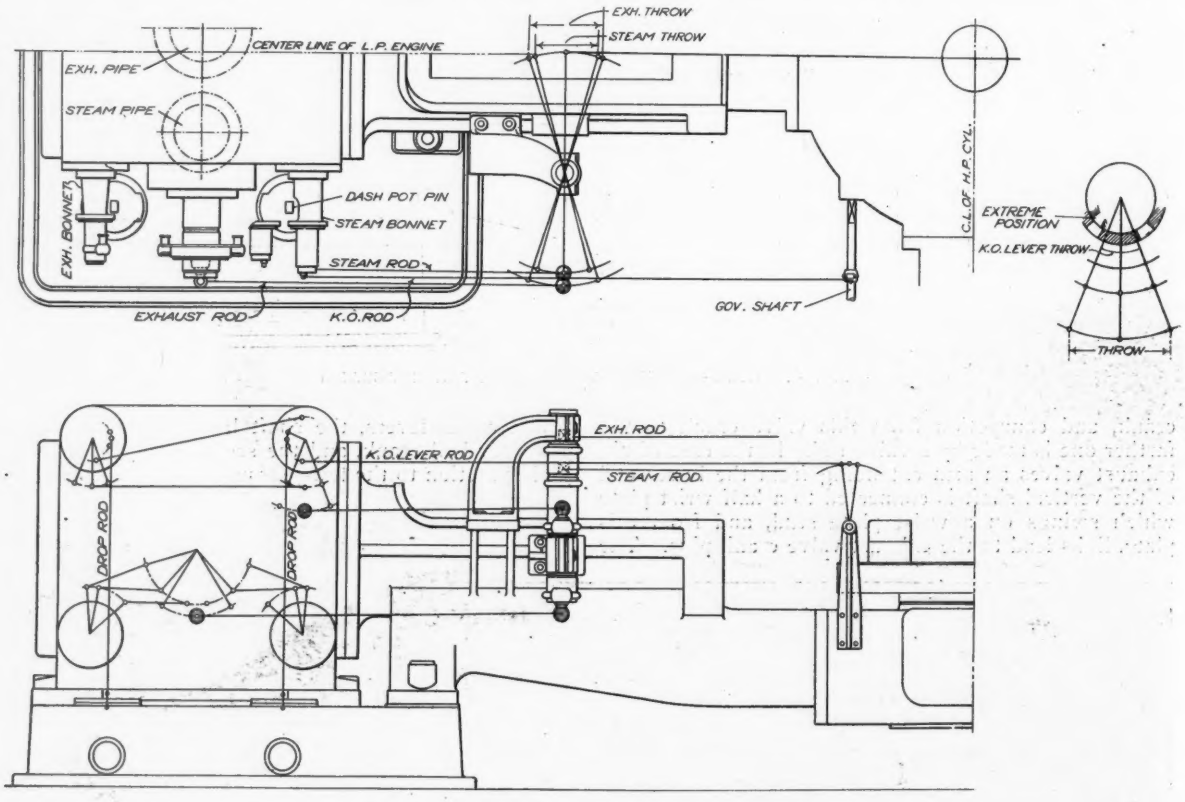


FIG. 5. LOW-PRESSURE VALVE GEAR AND DIAGRAMS

On the particular engine described the Wisconsin light duty governor is used, which, like the heavy duty, rotates at a high speed and is, therefore, sensitive and powerful. The heavy counterpoise weight is not driven from the spindle by means of the radius arms, but by means of a separate cross arm which drives the weight on a roller bearing, thus removing

friction from the joints of the fly weight mechanism. To avoid the effect of inertia on the parts controlled by the governor, the knockoff levers are operated by short, light governor rods and are arranged so that the motion of these rods is slight.

In the special illustrations of the valve gear and the valve diagrams it will be noted that the steam valves are double ported, the ports being 1½ in. wide in the low-pressure cylinder, with ⅜ in. lap in extreme position, and 63/64 in. opening at middle position. In the high-pressure cylinder the corresponding figures are, port width ¾-in., lap 3/16 in., opening at middle position, 31/64 in. Exhaust valves are also double-ported and as seen in the sectional illustration of the cylinder and valves, are so placed as to reduce to a minimum the clearance due to the exhaust passage.

Arrangement of the crosshead is, of course, different from that shown in the sectional view on account of the vertical shaft, but the arrangement of cylinders, valves and ports is as for the standard horizontal type engine.

One of the special features of this design is the yoke which carries the main bearing and to which the engine frames are bolted. This is of heavy girder design to span the pump pit and to take the side thrust coming from the connecting rods. The engine has cylinders 18 and 36 by 36 in., will run at 100 r. p. m. Steam is to be taken at 140 lb. per sq. in., and the condenser will carry a vacuum of 26 in. Under these conditions the engine is expected to develop 542 horsepower.

DETAILS OF POWER PLANT DESIGN III

SMOKE CONNECTIONS, CHIMNEYS AND DRAFT

By Charles L. Hubbard

Of equal importance with the boiler setting is the smoke flue between the furnace and the chimney. The smoke connections are usually of black iron, No. 12 gage for those of medium size and No. 10 for larger ones. Round pipes offer less resistance to the flow of the gases than rectangular, and this form is generally employed for the smaller sizes, and sometimes for those up to 36 in. in diameter, or more, where there is plenty of head room. Rectangular flues should be stiffened at the 4 corners by riveting the plates to angle irons running the entire length, and in the case of large sizes cross bars made up of tees or angles should be riveted to the flue at frequent intervals to give it additional stiffness. Smoke pipes of this kind are usually supported by overhead hangers, the rods of which are attached to the cross bars above mentioned or to special supports of heavy strap iron in the case of round pipes.

All smoke flues should be as direct as possible, and should be given easy bends where it is necessary to change the direction. If the main horizontal flue is of considerable length and without right angled bends, it is well to provide for expansion at the center by allowing one section to slide within the adjoining one, without riveting. Special care should be taken in cases of this kind to make a close though easy fit, and support the ends of the pipe in such a manner as to prevent buckling or displacement. One of the best plans is to anchor one section rigidly, and to arrange the moving end so that its weight will be supported on roller bearings.

Where the uptakes or bonnets from several boilers connect into the same flue, an adjustable hand damper should be placed in each, in order to equalize the draft of the different furnaces. After this adjustment has been made, the draft of the entire plant is regulated automatically by means of a single damper in the main pipe, controlled by a damper regulator, which operates with changes in the boiler pressure. Dampers of this description should turn on roller bearings, and should be set to close at an angle of 45 degrees with the horizontal position in order to make the movement as small as possible between an open and closed position.

Sometimes it is desirable, owing to limited head room and the necessary arrangement of steam and other pipes, to carry the main smoke flue beneath the boiler room floor. While it is always preferable to make the path of the hot gases continuously upward, the underground arrangement can be made to work satisfactorily by making the flue of ample size, with smooth interior, and bends of large radii. Flues of this kind are commonly made of concrete, and care must always be taken to make them absolutely watertight.

All smoke flues, whether above or below ground, should be provided with ample provision for cleaning, in the way of tight closing doors for reaching all parts of the interior.

The size of the smoke pipe is commonly based on the grate area, and in general, should be made about 1/7 the combined area of all the grates connecting with it. If the distance to the chimney is short and the draft strong, the size may be reduced to ⅛ or even 1/10 of the grate area in special cases. If the flue is of considerable length it is better to increase the size somewhat, if possible.

Chimney

THE modern office building is of such height that it is generally only necessary to carry the chimney a short distance above the roof, or just high enough to discharge the gases well above the tops of vetilating flues and pent houses. As the chimney is carried up inside the building walls, and is supported by them, it is only necessary to provide walls of sufficient thickness to carry their own weight, the factor of wind pressure being eliminated from the problem.

Sometimes the walls are of brick, with an air space for a portion of the height, and sometimes the flue is made of boiler iron carried up within a brick shaft. The latter arrangement has its advantages in that the space thus formed provides a heated flue for ventilating the boiler and engine rooms, toilets, etc., where a strong draft is required. This forms an economical method of ventilation, as the heat used in warming the flue and producing the draft would otherwise be wasted. In designing a chimney of this kind, the height is usually fixed to a certain extent by the height of the building, but this should be checked to see that it is high enough to produce the necessary draft for the kind of fuel to be burned.

The following methods taken from "Power, Heating and Ventilation" may be used for this purpose. One of these employs the rule that the square root of the height of the chimney, in feet, equals area of boiler grate surface in square feet, times pounds of coal burned per square foot of grate per hour, times 0.1, divided by internal area of chimney flue, which for average conditions may be taken as 1/8 the total grate area.

This rule will give approximately correct results for moderately free burning bituminous and medium to large anthracite coal. For free burning bituminous coal deduct 10 per cent from the height; for slow burning bituminous add 10 per cent; for pea coal add 15 per cent, and for No. 3 buckwheat add 25 per cent.

Some engineers determine the height of chimney by the grade of coal to be used and then compute the required flue area by one of the methods in common use. Chimney diameters for different heights may be taken from the accompanying table, which has been computed from Kent's well-known formula.

TABLE I. HEIGHT OF POWER PLANT CHIMNEYS

DIAM. OF CHIMNEY IN INCHES	HEIGHT OF CHIMNEY IN FEET						
	60	70	80	90	100	125	150
	BOILER HORSEPOWER						
24	54	58	62				
30	92	100	107	113			
36	141	152	163	173	182		
42	—	216	231	245	258		
48	—	—	311	330	348	389	
54	—	—	363	427	449	503	551
60	—	—	505	539	565	632	692
66	—	—	—	658	694	776	849
72	—	—	—	792	835	934	1023
78	—	—	—	—	995	1107	1212
84	—	—	—	—	1163	1294	1418

When basing the height on the grade of coal the following data may be used in plants of moderate size, and produce sufficient draft to force the boilers from 20 to 30 per cent above their rating. Free burning bituminous coal, 75 ft.; anthracite of medium and large sizes, 100 ft.; slow burning bituminous, 120 ft.; anthracite pea coal, 130 ft.; anthracite buckwheat coal, 150 ft. It will be seen that the above gives a somewhat higher chimney than the preceding rule, and for this reason is undoubtedly better adapted to power work where it is frequently desired to force the boilers or to change the grade of fuel.

Table I. gives chimney dimensions based on Kent's formula, as mentioned above.

Mechanical Draft

WHERE the chimney flue is carried up with the rest of the building it is not so expensive to erect as when it stands alone and requires special stagings, and again, as it is necessary to carry the flue above the roof, the chimney of the average office building is of sufficient height to produce a natural draft strong enough in most cases without the use of mechanical means. Many buildings of this class, however, are equipped with apparatus of this kind, in some cases because it is desired to burn a low grade of fuel requiring a very strong draft, and in others because it is required with the type of mechanical stokers in use.

A plant operating under mechanical draft may be run at its maximum capacity without regard to outside weather conditions, and also has the advantage of ease in regulation. It is especially useful in the case of electric lighting plants where the maximum quantity of steam is required for only a few hours a day. Forcing a boiler beyond a certain limit lowers its efficiency, but for short periods this is more than offset by the reduced first cost of the plant and the smaller operating expenses. The rate of combustion varies in different cases, but for lighting and power plants such as are commonly found in office buildings it usually ranges from 15 to 30 lb. of coal per square foot of grate per hour.

TABLE II. GRATE AREAS OF POWER BOILERS

LB. COAL BURNED PER HR. PER SQ. FT. OF GRATE	15	18	21	24	27	30
SQ. FT. OF GRATE REQUIRED PER HP.	0.22	0.19	0.16	0.14	0.12	0.11

When designing a plant for forced or induced draft the balance between coal burned per hour and heating surface must be maintained; that is, if the rate of combustion is increased, the grate area must be reduced in the same proportion in order to maintain the same economy. If too much fuel is burned, the heat cannot be absorbed by the heating surfaces of the boiler and the efficiency will be lowered.

Assuming a combustion of 0.3 lb. of coal per hour per square foot of heating surface, we have Table II., which gives grate areas for power boilers at higher rates of combustion.

The amount of air required per pound of coal with mechanical draft is, in practice, about 18 lb., although theoretically, only about 12 are required. This, at a temperature of 60 deg. has a volume in round numbers of 230 cu. ft. In the average case of natural draft this amounts to about 300 cu. ft. As all of the air supplied has to be raised to the temperature of the furnace gases, the reduction in the case of forced draft, should, theoretically, increase the efficiency of the boiler about 4 per cent under average conditions.

The strength of draft employed in this class of work commonly runs from 1 to 2 in. of water column, depending upon the quality and fineness of the fuel and resistance of the smoke passages.

Table III., compiled by the late Dr. R. H. Thurston, gives the pressure required to properly burn different grades of fuel. The forms of mechanical draft most commonly employed for this purpose are the forced draft system with closed ashpit, and the

TABLE III. AIR PRESSURE IN FURNACES

KIND OF FUEL	DRAFT PRESSURE IN INCHES OF WATER
GOOD STEAM COAL	0.4 TO 0.7
ORDINARY SLACK	0.6 TO 0.9
VERY FINE SLACK	0.7 TO 1.1
SEMI-ANTHRACITE	0.9 TO 1.2
ANTHRACITE SLACK	1.3 TO 1.8

induced system where the fan is placed in the smoke passage between the furnace and the chimney.

The closed ashpit system is the most easily applied to existing plants where it is desired to burn a cheaper grade of fuel, and is also necessary with certain underfeed stokers of the retort type. When this system is used, special care should be taken to distribute the pressure as evenly as possible throughout the ashpit by means of deflecting dampers or a large number of small inlets properly located for this purpose, and the blast gate should always be closed before opening the furnace or ashpit doors. Tables IV. and V. of fan

capacities and speeds are abridged from data published by the writer some 3 yr. ago. The first of these applies to fans for forced draft, and assumes a temperature of 60 deg. for the entering air, and a velocity of 2000 ft. per minute through the fan outlet or discharge which may be taken as average conditions.

With induced draft, a partial vacuum is produced within the furnace, and the result is much the same as that produced by the natural draft of a chimney. It is more easily controlled than other systems, and as the leakage is inward, all inconvenience from flame and dust at the fire and ash doors is avoided, and the fires may be made to burn more evenly.

When induced draft is used, a much larger volume of air must be handled by the fan because it has become heated in passing through the furnace and becoming mixed and combined with the gases of combustion, hence it has expanded on account of this rise in temperature.

The weight of air supplied, and therefore its volume when it enters the ashpit, is the same in each

TABLE IV. AIR PRESSURE IN FURNACES FOR FORCED DRAFT

DIAM. OF FAN IN FEET	WIDTH OF FAN IN INCHES	CU. FT. OF AIR DELIVERED TO FURNACE PER MIN.	PRESSURE IN INCHES OF WATER							
			0.5		1.0		1.5		2.0	
			R.P.M.	H.P. REQUIRED	R.P.M.	H.P. REQUIRED	R.P.M.	H.P. REQUIRED	R.P.M.	H.P. REQUIRED
2½	16	4,200	510	1.6	600	1.9	710	2.3	780	2.5
3	19	5,800	430	2.2	490	2.6	590	3.1	640	3.4
4	25	10,000	320	3.9	370	4.4	440	5.4	480	5.9
5	31	15,200	250	5.9	290	6.8	350	8.2	380	8.9
6	37	21,400	210	8.3	250	9.6	290	11.5	320	12.5
7	43	28,800	180	11.2	210	13.0	250	15.5	280	16.8

case, whether it is furnished by forced or induced draft. But when the heated gases reach the fan, in the latter case, their volume is much increased and the density correspondingly decreased. If a fan supplying forced draft should be used to produce an induced draft of the same intensity, the following

TABLE V. AIR PRESSURE IN FURNACES FOR INDUCED DRAFT

DIAM. OF FAN IN FEET	WIDTH OF FAN IN INCHES	CU. FT. OF AIR AT 60° DRAWN INTO ASH PIT PER MIN.	PRESSURE IN INCHES OF WATER							
			0.5		1.0		1.5		2.00	
			R.P.M.	H.P. REQUIRED	R.P.M.	H.P. REQUIRED	R.P.M.	H.P. REQUIRED	R.P.M.	H.P. REQUIRED
2½	16	3000	688	2.2	810	2.6	958	3.1	1053	3.4
3	19	4200	580	3.0	661	3.5	796	4.2	864	4.6
4	25	7300	432	5.3	500	6.1	594	7.3	648	8.0
5	31	11,100	337	8.0	391	9.2	472	11.1	513	12.0
6	37	15,600	283	11.2	337	13.0	391	15.5	432	16.9
7	43	21,000	243	15.1	283	17.5	337	20.9	378	22.6

changes would take place, their magnitude depending upon the temperature of the gases escaping from the furnace. First, the speed would have to be increased in order to maintain the same pressure; second, the power necessary to drive the fan at the higher speed would be greater than before; and third, the volume of air supplied to the furnace would be reduced. In Table V it is assumed that the gases of combustion reach the fan at a temperature of 500 deg., and the necessary corrections have been made for changes in speed, volume, and power to produce the same draft pressure as before.

When the volume of air called for at a given pressure comes between those given in the tables, small differences can be made by changing the speed, and larger ones by varying the width of the fan wheels.

TEMPERATURE RELATIONS IN BOILERS AND ECONOMIZERS

By G. F. Fenno

IN the generation of steam the object is to get the heat from the fire into the steam at the least possible cost. This cost per 1000 B. t. u. depends on the rate of heat transmission and upon the cost of surface, but the rate of heat transmission depends on the difference in temperature between the gases of combustion and the water and steam in the boiler; therefore if we know these temperature relations we can figure out whether each square foot of surface in the boiler and in the economizer is paying for itself.

Referring to the accompanying curves, we see that as the gases pass from the fire-bed through the boiler there is a gradual fall in temperature. This we have represented in the chart by a line AB. From the curve it is evident that the first few square feet of boiler surface are subjected to very high temperature heads, and hence transmit heat at an enormous rate, but this head becomes very small in the last passes and the amount of heat transmitted probably does not pay the charges against the surface. The chart has been calculated for a feed water temperature of 125 deg. F., with steam at 200 lb. pressure, or 388 deg. F., and gases leaving the boiler at 550 deg.

It is evident that there is a difference in temperature of only 162 deg. at the last end of the boiler, and the last few square feet probably do not transmit more than 400 B. t. u. per hour per sq. ft. Now, when these gases pass into an economizer they follow a

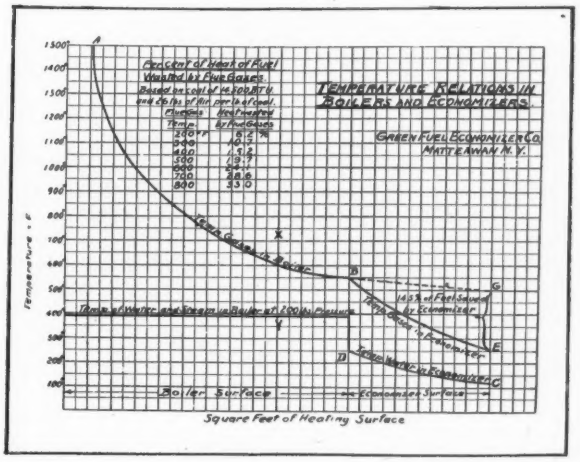

TEMPERATURE RELATIONS IN BOILERS AND ECONOMIZERS
GREEN FUEL ECONOMIZER CO.
MATTEAWAN N.Y.
Square Feet of Heating Surface

FIG. 1. TEMPERATURE RELATIONS BETWEEN BOILER AND ECONOMIZER

cooling law represented approximately by the line BE. There is, however, a notable difference in the water temperature in the 2 cases. In the boiler all of the water is at the same temperature as the steam, but as the economizer practically operates on the counter current principle, there is a steady increase in water temperature from inlet to outlet as shown by the line CD. Here it will be noted that the temperature head in the economizer averages much higher than the last quarter of boiler surface, hence it would seem that, as economizer surface only costs about half as much as boiler surface, with its attendant settings, grates, etc., it would be a much better paying proposition to cut off the boiler surface and start the

economizer surface earlier. This would give a much higher average difference in temperature throughout the combined units.

One of the most interesting points to note is that, had boiler surface been extended instead of an economizer added, AB would have been carried out to some point G, and the final temperature would have been about 500 deg. F. where the same amount of surface in an economizer reduces the temperature to 250 deg. F. The distance between E and G represents the quantity of heat saved by an economizer over what an equal amount of boiler surface would save. In the case shown by the curves it would have been impossible to reduce the flue gas temperature below the temperature of the water in the boiler, namely, 388 deg., whereas the economizer brought the temperature 130 deg. below that figure. Referring to the table of temperatures and heat lost, it is easy to figure out what this lower temperature saves in every case.

The argument based on this chart assumes that the coefficient of transmission is the same for the economizer surface as for the boiler surface, that is,

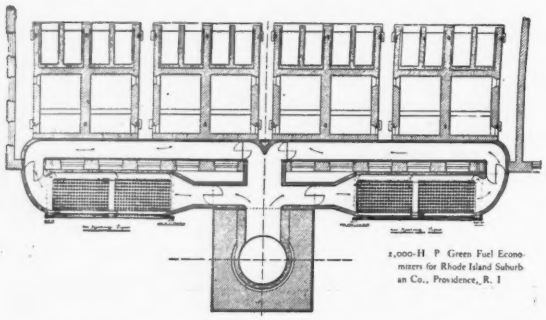


FIG. 2. ARRANGEMENT OF BOILERS AND ECONOMIZERS IN LARGE CENTRAL STATION

about 2½ to 3 B. t. u. per sq. ft. per hour per degree difference of temperature. The objection has been raised to this argument, and it has been claimed, that the boiler as a whole frequently shows transmissions of 5 to 8 B. t. u. per sq. ft. per hour per degree difference in temperature. This, however, does not vitiate the argument, for the coefficient of heat transmission is variable and is influenced not only by the velocity of the gases over the heating surface but also by the mean temperature of the gas film. In the hotter parts of the boiler this mean temperature is much higher than in the economizer, or in the last pass of the boiler, which accounts for the much higher average coefficient of transmission sometimes shown by the boiler as a whole.

When we come to consider the part of the boiler with which the gases last come in contact, however, it will be seen that the gas film has been reduced to about the same temperature that holds throughout the economizer itself, except in so far as the coefficient may be affected by the velocities of the gases in the boiler and economizer respectively. As for velocity, that over the economizer surface can be made greater or less than that over the boiler surface as we choose, by suitably modifying the proportions of the economizer. Considering therefore that the coefficient of heat transmission will not differ greatly in the 2 cases, it will be seen that the economizer surface will transfer heat much faster than does the latter part of the boiler surface, which still further decreases the cost of heat recovered by the economizer surface in comparison with the cost of heat recovered by the extension to the boiler surface.

The present chart has been figured out for only one set of conditions; but for other conditions of feed water temperature and steam pressure, similar curves will result.

Figure 2, a typical installation of a Green economizer, shows how the economizer is really a continuation of the boiler surface.

OIL ROOM AND WATER TANK SUPPORT

By W. F. Cox

SEVERAL months ago my company decided to replace 2 old 5000-gal. water tanks that had served their time, with 1 large tank. As it became the duty of the writer to select the type of tank best suited to the requirements and erect it, I decided on a 15,000-gal. red cypress tank with round hoops. The superiority of round hoops over flat hoops

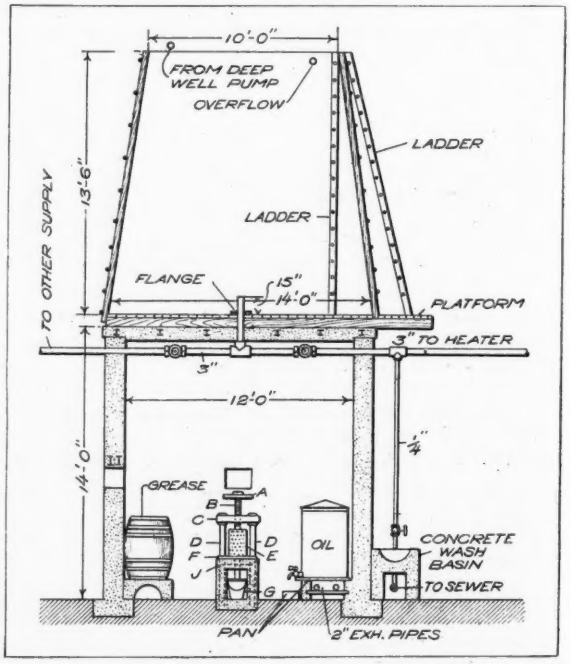


FIG. 1. VERTICAL SECTION OF WATER TANK AND OIL ROOM

is obvious; they are stronger and can always be kept painted all over, which protects them from corrosion and rust.

After deciding on the tank, the next and most important thing was the support for it.

Nearly everybody knows what a junk catcher the underneath of a tank supported on wooden beams and struts is; the timbers rot rapidly around the joints, where water happens to stand, and these timbers usually have to be renewed several times under a good tank.

As we were badly in need of an oil room, I decided to build a room with walls strong enough for the support of the tank, and use the room for the storage and handling of oils. Figure 1 shows a sectional elevation of the tank and room, and Fig. 2 is a plan view showing how the oil press, cans and barrels are arranged.

This room, which is constructed of concrete, was built by the writer with the aid of 4 negro laborers. Figure 3 shows the way that the forms were placed for running in the concrete. After laying off and putting in the foundation, which was 24 in. wide by 10 in. deep, the uprights shown at the corners of Fig. 3 were placed in position and well braced inside and out. These uprights consisted of 2 pieces 2 by 12 in. by 14-ft. plank nailed together at right angles to each other and then raised in position. Two of these sets were placed at each corner, one inside, the other outside, and about 15.5 in. apart, which gave a 12-in. wall when the 2 by 12-in. dressed planks were placed.

These planks were placed loosely between the uprights, as shown at B, Fig. 3, and were only tacked to hold them in place until the concrete work was put in. We used 4 planks to a side, which gave 24 in. to be put in at a time all around.

Before pouring the first run, the door frame was set in, and braced in the center to prevent the weight of the wet concrete bulging it inward. We also bored

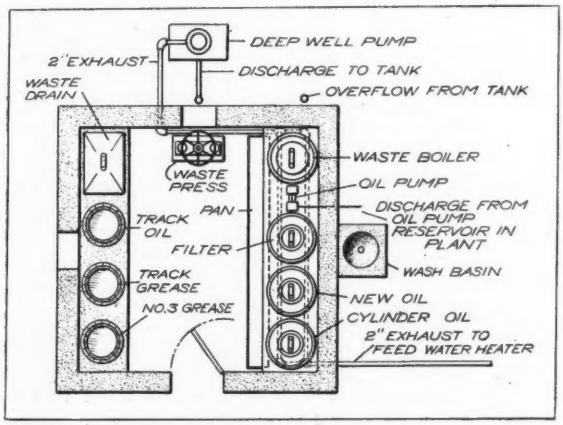


FIG. 2. PLAN OF OIL ROOM

a hole in the center of each plank and passed a ⅝ bolt through from the outside to the inside plank, to prevent the concrete from bulging these forms out. The planks were then well greased all over with a cheap grease to prevent their warping and allow them to be slipped up from the new work more easily.

Concrete was then mixed in proportions of 1:3:5—i. e., 1 part good portland cement, 3 parts sharp sand and 5 parts coarse gravel. The mixture was turned twice dry with shovels and once wet, and was put in wet enough to run. After filling the form all around, we stuck short pieces of old pipe, or any old iron we could get, into the concrete and allowed it to project up about 8 or 10 in., which reinforced the concrete and made a stronger bond between this layer and the layer that was put in next day.

This layer was allowed to stand until next morning, when the forms were carefully slipped up and the next 24 in. put in.

When we reached a height of 13 ft. the frames, together with the corner uprights, were removed, and some old steel rails, found around the yard, were placed diagonally across the top of the walls, bearing full on the walls and with centers laid 30 in. apart. Placing the rail diagonally allowed the weight to be distributed evenly on the 4 walls.

We next fastened a strip of 2 by 4 all around the top edge of the walls with the 4-in. side next the wall and the top edge even with the top of the walls, thus allowing the next course, which was to be about 10 in. high, to project over the wall, forming a 2-in. cornice all around, and also concealing the ends of the rails. The 2 by 12-in. planks we had been using were then fitted up inside within ½ in. of the bottom of the rail, concrete was run in and the whole beveled and smoothed off to form the roof. Placing the plank ½ in. below the rail inside allowed the rail to be concealed and made a neat ceiling.

All holes for pipes from the tank were allowed when putting in the concrete by setting in a piece of pipe 12 in. long and one size larger than the pipe that went through the wall; this piece was left in, as it made a neat appearance.

In about 15 days the tank was put up and placed in commission, resting on 4 by 6-in. timbers laid across the top of the room. These timbers were allowed to project 36 in. over one side as a platform.

After completing the tank I started in on the oil room furniture. The first thing was to construct the waste press, a view of which is shown in Fig. 1. The

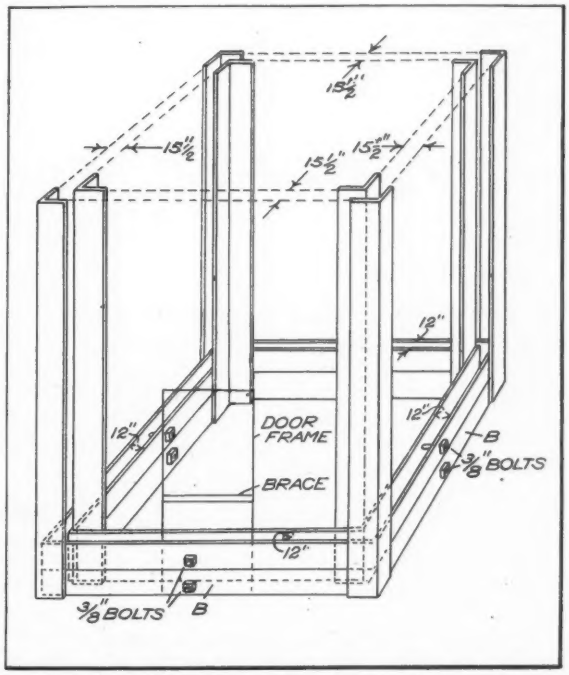


FIG. 3. ARRANGEMENT OF FORMS FOR MAKING CONCRETE WALLS

columns D D are made from 3-in. pipe about 5 ft. long, threaded on both ends; a running thread about 7 in. long on 1 end with a lock nut run down on it; the other end with half an old flange coupling screwed on to hold the columns from pulling up through the concrete which was cast around them. In casting the concrete an opening large enough for a bucket to catch the oil was left in, as shown at G, and across the top of this opening at J the concrete is reinforced with some old fish plates. A piece of 1½-in. pipe is also put in to drain the oil into the bucket.

C is a cast-iron head piece 4 by 6 by 30 in., with 2 holes cored out to allow it to slip over the top end of the columns resting on the lower lock nut. Another lock nut was then run down firmly on the head piece to hold it. B is a screw taken from an old 2 by 24-in. jackscrew, C being threaded to receive it, and allow it to run easily. A is the hand wheel, taken

from an old valve, about 18 in. in diameter. E is a piece of 8-in. pipe 14 in. long with ⅝-in. holes drilled in it and blanked on the bottom with a flange, also perforated. This pipe which forms the cylinder sets in a pan about 2 in. deep which has a nipple soldered in it and extending down into the 1½-in. pipe leading to the bucket. A cast-iron plate about ¾ in. thick and with several holes drilled in it just fits inside the 8-in. pipe and forms the piston.

Waste is pressed about every other day, the press being operated as follows: All the waste that can be crammed into the cylinder is put in and the screw run down as tight as possible by the hand wheel; a ¾ by 30-in. steel bar is then inserted in the holes of the screw and pulled down as tight as one man can pull it. The oil runs into the pan, thence into the bucket below, and is thrown into the filter near by, the waste being thrown into a boiler, made from an old iron drum 30 in. diameter by 48 in. deep. This has a perforated sheet-iron plate that just fits in it, and is held about 12 in. from the bottom by legs provided for that purpose. Upon this plate the dirty waste is thrown and covered with water; live steam is piped into the side near the bottom, and when the waste is ready to be boiled the cover is put on and steam turned on for about 20 minutes, after which the drain valve is opened, allowing the water to run out. The perforated plate holds the waste up and prevents choking up the drain pipe. The waste is then lifted out with a fork (like sauerkraut) and again pressed out, after which it is thrown into a can having an exhaust steam coil and dried out. This outfit saves us 100 per cent in oil and waste.

Oil tanks, of which there are 3, including the filter, are 30 by 48 in., the filter being made according to the writer's ideas, and has a large filtering capacity and does excellent work. These cans with the boiler and an oil pump are arranged alongside the right-hand wall on hollow piers running the full length of the room. Two 1½-in. pipes are run inside this pier and directly under the cans. Exhaust steam from the deep well pump, just outside, is carried through these pipes, which are in multiple.

This arrangement keeps the oil warm, and is a great help in winter when drawing cylinder oil. New engine oil is emptied into the tanks with compressed air.

The other side of the room is given over to greases and heavy oils kept in barrels for car and track use.

Outside and convenient to the water supply we built a concrete wash basin, for summer use, as shown.

SOURCES AND METHODS OF PRODUCTION OF LUBRICATING OILS

By W. A. Converse*

IN THE United States the yield of crude petroleum comes from what we might term the 6 great oil provinces, viz.:

The Appalachian field; the Lima-Indiana field; the Illinois field; the Mid-Continent field; the Gulf field; the California field, and to a small extent from lesser fields of minor importance.

Petroleums from the Appalachian field are practically free from sulphur and asphalt, rich in paraffin wax, and yield the largest per cent of gasolene and illuminating oils. The field extends from western New York in a generally southwesterly direction, along the western side of the Allegheny Mountains, through Pennsylvania, eastern Ohio, and West Virginia, into Kentucky and Tennessee. In the latter states, especially, the quality of the oil varies so markedly within even short distances that the product frequently resembles the sulphur oils of the Lima-Indiana field.

The Lima-Indiana field yields oil containing sufficient sulphur to require in most cases special treatment for the elimination of this elment as far as possible. Like the Appalachian oil, it yields paraffin wax. The field includes the northwestern part of Ohio and a strip in the middle of Indiana, and formerly included Illinois, but this latter field, as before stated, is now in a class of its own.

The doubt as to the advisability of including the Illinois field with the Lima-Indiana field was brought out in report of the U. S. Geological Survey in 1906, this doubt being based on the fact that the oil is produced from a different geological strata. Careful and extended examination of the product confirmed the necessity of making this a separate field. The oil contains less sulphur than that from the Lima-Indiana field, so that it is possible to refine much of it without special treatment. Many of the oils from this field contain both paraffin and asphalt as a base. The oils vary much in gravity and distillation products.

The field comprises a narrow area in southeastern Illinois near the Indiana line. Much drilling has been done elsewhere through the state, by which smaller and isolated pools have been found.

The oils of the Mid-Continent field also show considerable variation in physical properties and the per cent of different distillation products that they yield. Many contain asphalt as well as paraffin. The field includes southwestern Kansas, Oklahoma and northern Texas.

Geographically the Gulf field includes all oils in Texas and Louisiana. The oils near the Gulf contain rather large quantites of sulphur, much of which is present in the form of sulphuretted hydrogen gas. The presence of so much sulphur demands a treatment of the crude before submitting it to the process of distillation in order to remove the sulphur. The sulphuretted hydrogen being a gas, it can be and is removed to a large extent by steaming. The sulphur is sufficiently high to warrant a steaming of the oil before using it even as a fuel.

Their geographic location makes the products of the Gulf field well suited for fuel oils, especially for export. The lubricating oils produced therefrom are not considered of as good quality by far as those from certain crudes coming from the Appalachian field, especially from Pennsylvania. The gasolene obtained from these crudes, very peculiarly, is a much better solvent than that from other fields.

*Chemical Director Dearborn Drug and Chemical Works, Chicago.

California oils are generally characterized by much asphalt and no paraffin. Generally speaking, they vary in gravity from 9 to 22 deg. Beaume, usually ranging between 14 and 19. Upon distillation they produce none of the lighter oils, such as gasoline, benzene, or naphtha, and but about 7.5 per cent of kerosene. The heavier of these crudes are being distilled for the primary purpose of obtaining the asphalt, the average yield amounting to approximately 45 per cent of the crude.

There are some lighter crudes found in this field, but in comparatively small quantities. Most of the petroleums of this field contain material amounts of sulphur and nitrogen. An endeavor is being made, by methods of acid treatment, etc., to produce from some of the intermediate distillates obtained from this class of crudes, coming from stills following the removal of the small amount of kerosene, oils that could be marketed satisfactorily as lubricants, but with only partial success, as the products when compared with those from the better petroleum are very inferior in lubricating value.

Small quantities of oil have been for many years produced in Wyoming, Colorado, Missouri and Michigan. During 1907 a small field of heavy oil was developed in southwestern Utah. The yield, however, up to the present time is negligible.

Production

GOOD, general idea of the production of the several oil-bearing states and territories, average price per barrel and total value can best be obtained by reference to tables given herewith. The data incorporated were compiled by the U. S. Geological Survey and taken from its last printed report, dated 1908. While over a year has elapsed, the tables will, I believe, answer the purpose at this time

OIL PRODUCTION BY STATES.

State	1908 Production No. Bbls.	Total Value
Pennsylvania	9,424,325	$ 16,881,194
New York	1,160,128	2,071,533
Ohio	10,858,797	14,178,502
West Virginia	9,523,176	16,911,865
California	44,854,737	23,433,502
Kentucky	727,767	509,436
Colorado	379,653	346,403
Indiana	3,283,629	3,203,883
Illinois	33,685,106	22,648,881
Kansas	1,801,781	748,018
Texas	11,206,464	6,700,708
Missouri	15,246	.....
Oklahoma	45,798,765	17,694,843
Louisiana	6,835,130	4,131,173
Wyoming and Utah	17,775	.....
Total	179,572,479	$129,459,941

Oil Production by States.

The reader's attention has been called to difference in makeup and character of oils from the different fields. These differences materially affect the quality of the different crudes so far as the quality and quantity of the different marketable products which they will produce are concerned. Apparently, the price is based upon the quality of the crude when considered as a probable source of high-class lubricating products, as those which demand the highest price in the open market are known to produce lubricating products in small quantity as compared with the amount of crude from which they are produced, but of very high quality and especially suitable for use for lubricating purposes. Therefore, the writer feels justified in giving a reproduction of a table published in one of the authoritative oil journals or papers of the country. While there is some fluctuation in these prices from time to time, there has not been during the past several years sufficient to detract from the table for the purpose for which it is shown, as the relative differences are almost invariably present.

VARIATION OF PRICE WITH LOCALITY.

	1910 Price per Bbbl.
Pennsylvania dark	$1.40
Second Sand	1.40
Tiona, Pa.	1.40
Cabell, Pa.	.97
Mercer black	.90
New Castle, Pa.	.87
Corning, Pa.	.79
Butler, Pa.	1.40
North Lima, Ohio	.84
South Lima, Ohio	.79
Indiana	.79
Princeton, Ind.	.60
Somerset, Ky., 32 deg. and above	.72
Ragland, Ky.	.45
Casey, Ill.	.60
Illinois, heavy, below 30 deg.	.52
Kansas and Oklahoma, 30 deg. and above	.35
Below 30 deg.	.28
Corsicana, Tex., light	.70
Heavy	.53
Henrietta, Texas	.53
Humble	.75
Saratoga, Texas	.75
Sour Lake, Texas	.77
Jennings, La.	.54
Shreveport	.52
Spindletop	.80
Batson	.75
Dayton	.72
Canadian Oil:	
Petrolea	1.24
Oil Springs, less pipeage	1.31

Variation of Price With Locality

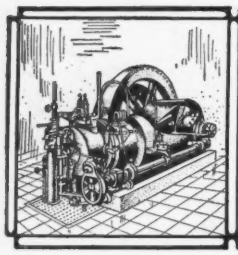
The prices given in the table are at the wells, and necessarily there is the item of cost of transportation from wells to refinery, which is accomplished principally by means of pipe lines. A minimum charge of 20 cents per barrel is made for this service, the charge increasing as the distance increases, and being also influenced by the status of other transportation facilities. For instance, the charge per barrel from the Illinois field to Pennsylvania refinery is approximately 47 cents a barrel.

The writer's remarks thus far have been confined to the petroleum of the United States. There are, however, in other countries productive fields of varying importance, which time will not permit of discussing. The accompanying table will show the production by countries, in barrels, which may prove of interest to the reader:

WORLD'S PRODUCTION OF CRUDE PETROLEUM, 1908, BY COUNTRIES.

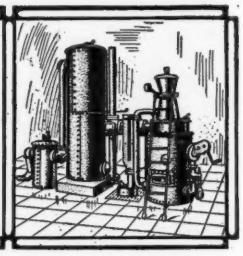
	1908 Production in Barrels of 42 Gal.	Percentage of Total Production
United States	179,572,479	63.09
Russia	62,186,447	21.85
Sumatra, Java and Borneo	8,752,822	3.08
Galicia	12,612,295	4.43
Roumania	8,252,157	2.90
India	5,047,038	1.77
Japan	2,070,929	.73
Mexico	3,481,410	1.22
Canada	527,987	.19
Germany	1,009,278	.35
Peru	1,011,180	.36
Italy	60,000*	.03
Other	30,000*	
Total	284,614,022	100.00

*Estimated.



Gas Power Apparatus

Producers, Engines and Industrial Applications



GAS ENGINE EFFICIENCY AND EQUIPMENT*

EFFECT OF IGNITERS, CARBURETERS, BATTERIES, WIRING, ETC., ON ENGINE PERMORMANCE.

By Charles Kratsch

ACTIONS speak louder than words, and this matter comes home to me as manager of the Gas Engine Department of the Colbonne Mfg. Co., with practically 100 internal combustion engines on our floors all ready for immediate shipment. Engines range from 1 hp. for operating a cream separator to 125 hp. multiple-cylinder, verticals for generating electric current. The makes of engines include the old style slide valve "Otto" of 30 years ago, up to the modern type "B" "Columbia" of the same make. On our floors today are, to be exact, 92 engines that average 20 hp., and these are of 32 different makes —each equipped with flywheels, base, crank shaft, cylinder, pistons, rods, valves and igniter plugs.

Most of these modern master piece power producers are built right, no expense having been spared by their makers to bring them up to the high standard of modern machines; and we, as mechanics (and called "Gas Engine Experts") sell these machines to our friends and customers, and equip them—these high-grade good engines—worth hundreds of dollars—with battery switches, one of the most important adjuncts to the gas engine ignition apparatus, that cost 17 cents each. We connect such a switch to batteries or to a magneto with wire that costs 75 cents for 100 ft., shipping with this stationary engine as our advertisement states "The same equipment in new accessories as originally furnished by the builder."

But in marine service, for motor boat engines for pleasure principally, we furnish a switch that costs ten times the money—and—wire that is worth $18 for 100 ft., and, furthermore, with this wire we send terminals to be soldered to it so that the connections will not work loose. On the stationary engine they have to skin the wire and wrap it around an electrode or underneath a cap, with the ravelings of thread spread all around the terminals in a manner that reminds one of his boyhood days and a rag on an old sore toe.

In a motor boat or automobile these wires are permanent and properly installed, or better still are dispensed with almost entirely by direct connected magnetos that eliminate 90 per cent of ignition trouble; and why? Because somebody has set what might be called a Standard. While on the stationary engine—well—it is but a few years ago that we were lucky to get a hot tube torch tank with the engine frame, let alone extra parts, a set of wrenches or other accessories.

If the builders, who make these engines, won't set us a good example, we who rebuild them will set one for you, and the next lucky buyer who purchases one of your engines from my company, is going to get that engine equipped as the dignity of its good name demands. We will set an example for you that will be advantageous for you to follow, and we hope you will improve on it and set a standard of excellence for the trade in general.

Ordinarily the construction of an engine is simple. No mechanical reason exists why an engine, built on correct lines, of good workmanship and proper material, efficient at first, should not continue to run well for an indefinite time, since the functions of the comparatively few parts which comprise its mechanism may be readily understood, and a short time given to the study of the subject will establish all the knowledge necessary for its proper care.

Perhaps the most vital part of any internal combustion engine is in the ignition—for if the engine is not provided with a proper ignition it is vitally defective. Some makers prefer jump-spark, and others, make and break. Either is effective if the conditions are favorable to the system employed. Some of the points to be considered in this relation are: whether the engine be of small or large size, whether the fuel be high or low in heat units and in ignition responsiveness, and whether the system of governing the speed be hit and miss of the throttling design.

Accessories for engine ignition ordinarily are either dry or wet batteries or storage batteries, magneto and coil, or high or low tension magnetos and kindred special sparking devices. The best of these is none too good, and personally I would like to see each stationary gas engine constructed without superfluous wires, batteries or coils, but with special ignition devices that are built into the engine and made a part of it. Some of these devices are here now; they are being made better and cheaper all the time, and inside the next few years an engineer should be able to start up a stationary gas engine just as easily as he starts his automobile.

In the jump spark ignition system one of the most persistent causes of shut down is in the spark plug itself. A poorly designed and badly made plug is a bad investment in engine accessories for any maker. A bad coil or a weak one will give trouble until the constant delays make the user disgusted. Of course in the majority of such cases the gas engine itself and the gas engine business, not the faulty accessory, gets the blame.

*Abstract of a paper read before the National Gas and Gasoline Engine Trades Association.

Save money if you must on your manufacturing cost, and not at the expense of your ignition system, or vital accessories.

Our firm does about 60 per cent of the repair business on gas engines in or about Chicago, and after I had been requested to prepare this paper I tabulated the last 100 calls we had. I append hereto the results which I confess surprise me. Some of these I frankly admit were your engines rebuilt and sold by us. All of these calls come in to me, and go out by my orders, and the trouble men report back.

Here is the list and I offer it for your serious consideration:

Causes Due to Installation, 7 Per Cent.

1. Engines installed by purchaser to save first cost.
2. Gas bag too far from engine.
3. No coil in ignition circuit.
4. Water supply to cylinder reduced so that engine got hot and stuck.
5. Engine flywheel-gears not in proper mesh with cam-shaft gear.

Causes Due to Fuel, 13 Per Cent.

1. Lack of proper supply of fuel—blamable on carburetors or mixing valves, fuel supply pumps, or piping clogged.
2. Fuel tank too far from engine to feed at all times sufficient fuel.
3. Gas bag too small or too far away. (We need some one to give us a proper design of gas reservoir. Rubber bags are rotted by the oil if placed where they should be, over the inlet valve.)

Lack of Proper Instructions for Operation, 10 Per Cent.

1. Man who runs engine or engineer not familiar with the functions of the different parts.
2. Too much or too little gas.
3. No cylinder oil.
4. Running engine too cold or no water at all.
5. Batteries weak or dead.
6. Defective vibrator on coil or coil out of adjustment.
7. Too much or too little air for proper mixture.
8. Parts put together wrong after the Saturday night tinkering by the man in charge. (This was why the Internal Combustion Engineers Association was formed, and I am proud to say we are doing extra work on these lines.)

Cause Due to Faulty Construction, 5 Per Cent.

1. Defective parts blamable to design, such as a crank shaft of too small dimensions.
2. Not sufficient area to valves.
3. Raising valves late or for too short a time.
4. Not enough lift to valves for a perfect mixture or clear exhaust.
5. Bad gasket faces—poor gaskets causing water leaks.

(A ridiculously small percentage that can be blamed to mechanical construction or design—only 5 per cent.)

Cause Due to Natural Wear and Accident 17 Per Cent.

1. Cylinders worn—need reboring.
2. Broken shaft, cut, sprung, or crystallized.
3. Valves reground.
4. Governor fingers played out.
5. Lost motion in brasses on rod or other bearings.
6. Loose flywheel.
7. Gaskets blown out.
8. Crystallization of connecting rod studs.
9. General overhauling.
10. Engine totally wrecked.

Causes Due to Ignition Troubles, 19 Per Cent.

1. Parts inside engine, blamable to wear, and neglect.
2. Movable electrodes worn out.
3. Igniter casting requiring new bushings, new points, springs, etc.

Equipment and Accessories, 29 Per Cent.

Twenty-nine per cent due to accessories, and subdividing these once more to bring out that 12 per cent were troubles that could have been anticipated, and shutdowns eliminated, if an extra igniter were furnished.

Eleven per cent ignition troubles were caused by poor wire, defective switches, bad installation of wiring, and poorly connected terminals; burnt out coils, poor magnetos or cheap batteries. Six per cent by points burned off by magnetos being over speeded, caused principally by oil on flywheels, friction governor not acting or set too close. Ignition current taken from light circuit, etc.

Twenty-nine per cent of all engine shutdowns could be saved. Twenty-nine per cent of all gas engine troubles could have been eliminated by spending a few extra dollars on first cost.

One of the best paying engines we ever handled was an engine designed for extremely low building cost, but the ignition apparatus, carbureters and accessories were of especially high grade. That engine gave us less trouble than any other because when sold it stayed sold, and did not lose us our profits on the original sale by keeping a troubleman tinkering with poor accessories.

A capitalist once intended investing in a company with which I was connected, but turned down the proposition "Because we made gas engines as a side line." This engine was equal to any built at that time, but at the best was not as reliable as gas engines are today. They lacked efficiency not owing to general design, but to the poor grade of essential equipment on the market at that time.

Let us make our installation standard; use copper terminals; run your wire leads on porcelain insulators and keep them out of the oil; or better still, eliminate oil splash by suitable oil guards. To obtain high efficiency, accessories must be of the best grade, and until such a time as the manufacturers succeed in making and shipping engines with

1 Ignition apparatus attached or closely connected to the engine frame,
2 Water thermostats,
3 A type of mixer which will regulate the air supply and its temperature and humidity as well as regulate the gasoline supply,
4 Carbureters that will require practically no adjustment,
5 With mechanical oiling devices that need merely the filling of the reservoirs,
6 With extra igniters,
7 With full set of wrenches,
8 Good gasometers,
9 Proper instructions,

we must expect shutdowns, for internal combustion engines do depend on equipment for their reliability.

GAS PRODUCERS*

By H. F. Smith

IT is not our purpose to discourse on the advancement that has been made recently in the realm of producer gas power, although the development has been rapid and extremely interesting. Our topic at this time can perhaps be best expressed by the following question: "Why has producer gas power failed in the United States?"

In England and Continental Europe producer gas power has most certainly not failed, and we do not mean to imply by the above that there are not many truly successful gas power plants in the United States.

But a careful perusal of the true inside history of a great majority of the gas power installations that have been made in this country in the past 5 or 6 years will reveal a state of affairs that is far from satisfactory from the standpoint of one interested in the fullest success of this type of power.

Unfortunately, failures do not all die young. If they did the gas power cemetery would be a very robust institution, and the industry, or that part at least that remained unburied would be in a much more healthful condition.

The failure that works the greatest hardship on all concerned is the one that keeps on running, and is owned and operated by a disappointed individual who fondly imagines he knows all about gas power because he has one of the things in the back end of his shop. This is the man from whom the power-using public gets what it considers authentic information on gas power. This is the man who has prevented, in a large measure, the growth of the producer gas industry in the United States on a scale comparable with the development that has taken place abroad.

Such observations as we have been able to make on this subject, however, have led us to the conclusion that the responsibility for this condition is pretty uniformly distributed. There seems to be little question but that the designer, the salesman, the erector, the purchaser and the operator have each contributed his share toward this very undesirable state of affairs, and in each instance it seems that trouble has originated largely through lack of attention to detail.

We would like to pause long enough at this point to remark that minute attention to detail is essential to the successful operation of practically every piece of mechanical apparatus in use today. In an electric motor, for example, it is vastly important that the armature core be built up of laminations of iron of a certain peculiar quality, and that a certain particular direction and form of winding the wires must be carried out. A hundred details must be followed with the utmost exactness if the resulting machine is to give really satisfactory service as a motor.

Furthermore, the designer must know in advance considerable about the nature of the service the motor is to perform. If for starting heavy loads, a series-winding will be required; if for constant speed, shunt winding would be better, and so on for numberless variations, each condition being met by those special details of design, construction and care that experience has demonstrated to be necessary to success. Any machine in common use today is capable of the same sort of analysis as to details that are absolutely essential to the success of the apparatus.

Since such multiplicity of detail envelops every successful piece of apparatus in use today, it would seem no more than reasonable to presume that there are details of design, details of construction and details of operation that are essential to the truly successful operation of a gas producer power plant. A perusal of much of the literature published on the subject of gas producers, however, and particularly that intended for the perusal of the average mechanical man, conveys the impression that a gas producer resembles very particularly a kitchen range, and consists essentially of a grate, a firepot and a piece of pipe to take the "smoke" to the gas engine. The worst feature of all of this alleged information lies in the fact that it is strictly true as far as it goes. The only purely false note is the falling accent at the end, which implies that all has been said that is to be said regarding gas producers. It is astonishing to think that anyone, and particularly a skilled mechanician or a manufacturer should be misled by such conclusions, but it is painfully evident that many people have accepted such statements as the above not only as the truth but as the whole truth.

Perhaps we can get an idea of how these things come about if we consider a hypothetical case. We will presume that a gas engine manufacturer desires to extend the market for his wares by the use of producer gas. He has probably been much impressed by the descriptive matter published everywhere concerning the almost elementary simplicity of the suction producer. Obviously, such a machine must be very cheap to manufacture. The total weight of metal is not great. There are no complicated parts to machine, and really there is nothing to it at all. On investigating selling prices, he finds that these are apparently very high. The manufacturer immediately smells a nice fat graft that is evidently being worked in this new power, and determines to come in for his share of the pie. His chief designer is therefore instructed to "bring out" a line of gas producers.

In order to get some idea of the snares and pitfalls that are laid for this man's feet, try to imagine if you can, a designer equally competent in other lines, who is called upon to bring out a line of steam boilers. The extent of his knowledge of the subject is confined to the following alleged facts which he has read: "A boiler is a very simple piece of apparatus which much resembles a teakettle. It consists of a shell of sheet metal fitted with tubes. A furnace is placed underneath to supply heat. Water is placed within the boiler and when this is heated steam is produced. As built in England and Germany, some boilers have tubes 16 inches in diameter and some have tubes one-half inch in diameter. Both kinds work well. A pipe leads the steam from the boiler to the engine and another pipe leads from the furnace to the outside air."

Please remember, now, that the above is absolutely all the information this man has. He can not turn to a voluminous textbook treating in detail on the strength of riveted joints, on the ratio of heating surface to grate surface, on the design of stacks, on the question of internal circulation and priming, on

*Abstract of paper read before the National Gas and Gasoline Engine Trades Association.

disengagement area, mud drums or blow-off connections. All of these things are a sealed book to him. He never ran a boiler 6 months in his life, and has probably seen 2 or 3 from afar off. Does the imagination need any assistance to picture the kind of boiler that would result? Suppose he would decide to use half-inch tubes and try to fire it on bituminous coal. Suppose he would locate the water gage 6 in. below the crown sheet. Undoubtedly his boiler would make steam, but would you consider such a boiler as a worthy piece of power-house equipment?

Suppose that 3 or 4 designers, equipped as above, with variations, brought out and placed on the market as many different designs of boilers. You can imagine the general impression of the steam boiler one would get from examining several such installations.

Mr. A's boiler has been running fairly well for a year. The bottom sheets are badly damaged, due to an accumulation of scale, no hand holes having been provided for its removal. Coal consumption has been steadily increasing till the furnace will no longer burn enough to develop rated power. The boiler will probably not stand for more than another year's service.

Mr. B's boiler gives no trouble from scale, since mud drums and blow-outs are provided and regularly used. The half-inch flues, however, must be cleaned out every half hour, and considerable trouble is experienced from water going over to the engine.

Mr. C's boiler will not develop its rated power, as it is furnishing steam to a pump that takes 100 lb. of steam per horsepower hour. Can't get over 50 actual hp. out of it, although it was guaranteed to be a 100 hp. boiler. This boiler was mounted in a brick setting, each end resting directly on the brick. The setting has cracked badly and will need to be renewed about every 6 months. Boiler is also leaking in the seams.

Mr. D's boiler has been running right along and giving good satisfaction. The flues are rolled in every Saturday night and by having an extra large feed pump, the leakage can be taken care of until the next Saturday. The tubes generally stay tight till Tuesday morning, and on Thursday the fireman puts corrugated roofing over the furnace to keep the water off the fire. During the latter part of the week a large centrifugal fan is started to assist the draft. The owners report that they have never lost a minute and feel certain that they have a very representative steam boiler plant.

We believe we have carried this illustration far enough to show clearly the vital importance of detail in design, and to show, briefly, how seriously this can affect the present and future of the producer gas industry, for detail is just as important, just as complex and just as far reaching in its bearing on true success in gas producers as in steam boilers. There has been far too much general information, and far too little specific information in print regarding gas producers.

Many gas producer plants are badly sold. The modern machinery salesman must be something of an engineer. No system of power generation is applicable to all uses, and producer gas power is no exception. You certainly would question the selling ability of a man who would recommend a turbo-generator set for the power equipment on a portable sawmill. Yet greater atrocities are committed daily in the name of gas power.

Much is embraced in the term "engineering," as applied to salesmanship. It may be said to consist in exercising toward the producer gas power installation that same discriminating care as to detail that is almost instinctive in other lines. This involves on the part of the salesman an exact knowledge of the characteristics of his apparatus and an engineering sense strong enough to compel him to forego a sale rather than make a poorly advised installation.

A good engine and a good producer, even when well sold and perfectly suited to the work in hand, do not constitute a successful gas power plant. Each detail of the supplementary equipment and of the arrangement of the various parts of the plant, contributes in no small measure to the final result. These matters can not be safely left to the discretion of the purchaser, since he has had no experience, and consequently has no basis for judgment. To use our illustration of the steam plant again, a good boiler and a good engine do not constitute a good power plant when joined by 400 ft. of bare pipe in zero weather.

This matter of minor equipment, or plant auxiliaries, is one that has been very sadly neglected, and lack of attention to these details has been the cause of more or less complete failure in many plants otherwise well equipped.

We will touch but briefly on the subject of erection. Unfortunately, gas power plants can not be shipped already assembled. No machine will work properly unless properly erected. As a rule, the best invested part of the cost of a gas power plant is in the money spent for the services of a competent erector. We might pause to remark that a good erector must also be a good teacher, to be able to impart a necessary part of his knowledge to the future operator of the equipment.

Buying and selling are very intimately associated, but the purchaser of gas power equipment has developed a few particularly original stunts that certainly deserve special mention. One of the first men we meet in selling is the man who is after a binding guarantee. He has these two words printed on his physiognomy in large black letters and gives little thought to anything else. He will expect a specific guarantee covering every possible or impossible contingency from thermal efficiency to terms of settlement, and he usually manages to work in a few stunts that require the plant to be more or less miraculous in its attributes. Now, guarantees are peculiar things. There are in general, 2 kinds—the kind you expect to live up to and the kind you expect to get out from under. When one has been concerned in demonstrating producer efficiency on 10 or a dozen different occasions, the business of pursuing the festive heat unit becomes a very serious undertaking, and a difference of 4 or 5 per cent on an efficiency guarantee assumes somewhat startling proportions. The ease with which plant performance on the customer's premises can slump from the conditions of a factory test means considerable to the man who has been through, but not much to the man who has not.

As an antithesis of the man who buys guarantees, we have the man who only wakes up to the wonderful possibilities of gas power after his plant has been running for a couple of months. This man communes with himself as follows: "I certainly have here a remarkable piece of machinery whose possibilities even the manufacturers only faintly realize. I find that my producer will run all day without attention. Why will it not run 2 days, and if 2, why not 3?"

This theory, he immediately proceeds to put into practice, and he probably finds that it will run 2 days or 3—instead of one only. The trouble with this man is that he soon gets to expect this kind of care-free service, and is disappointed if he doesn't get it. To illustrate, I will quote from a letter recently received at our office:

"Gentlemen: We regret to advise that we are having a lot of trouble with our producer, and we think there certainly must be something seriously wrong with it or with the way your man put it up. As you know, we run 24 hours per day. The plant seems to run good enough through the day when our man is around, but frequently when he comes back in the morning he finds the plant has stopped during the night."

Between these 2 extremes we have a large class of careless buyers, who, through lack of discrimination, are the indirect cause of many ill-advised installations. These are the men who have read—and believe—that a producer is quite too simple to have details worthy of consideration, and that any gas engine is a producer gas engine.

We believe that the purchaser of power equipment will soon appreciate that gas power is a good investment only when discriminating care is given to every detail down to the very last. When this time arrives the beginning of the day of successful gas burner installations will have dawned.

The question of operation of producer gas power plants is one which deserves much greater space than we will be able to give it at this time. It certainly seems to the writer that those who are engaged in the profession of operating power equipment have given this matter far too little consideration.

The importance of every particular detail of plant operation in connection with steam power has been drilled into them for generations. The time to begin educating a man is with his grandfather. Two or 3 generations hence we will undoubtedly have an ample supply of competent power plant operators in connection with gas power, as the present steam plant men who are thoroughly cognizant of the importance of keeping water in the gage glass and scrap iron off the safety valve.

Eventually we may hope to see published details of how to handle in a thoroughly satisfactory way the details of producer gas power operation in the same manner that we frequently see these matters detailed for steam.

We have confined our remarks largely to the producer end of the installation. We wish to state here, however, that the engine builders are by no means fault-free in this regard. A good gas engine is by no means necessarily a good producer gas engine, and it is disappointing to note how few gas engine builders fully realize this fact. An engine that will turn over and develop power on producer gas may come a long ways from being a factor in a successful gas power plant. The fact that a plant runs, does not constitute it a success. The fact that it has been paid for and that the owner is not entering daily complaints does not necessarily constitute a successful plant. Success is, of course, a purely relative term, and by success in gas power installations we mean the same measure of faithful performance, reliable operation and freedom from annoyance that characterize the operation of a first-class steam outfit. We have tried to call attention to the fact that such a steam plant is successful only because of minute attention to every detail of design, construction and operation, and that we can not hope to have an equal measure of success with gas power until the manufacturer, the purchaser and the operator all realize the importance of such detailed consideration.

The writer would have preferred on this occasion to have discussed a more cheerful phase of the gas power question, but it has seemed that perhaps more lasting good could be brought about by presenting for consideration some of the things that seemed to stand in the way of a fuller realization of our hopes in connection with the future of producer gas power.

EXPLOSIONS IN INTERNAL COMBUSTION ENGINES*

EFFECT OF FREQUENCY ON UNIFORMITY OF ROTATION

By Alex. W. Mosely

IN connection with the subject of the evening it may be of interest to mention a new type of indicator motion which is constructed to take continuous cards. While a continuous indicator card is not altogether a new development, heretofore instruments for producing these cards have been of the reciprocating type, which advance the card only part of its entire stroke, while with the new type of indicator the card travels the full length of the indicator stroke, registering the actual piston travel, always in the same direction. An illustration of a card taken by one of these instruments is shown in Fig. 1.

While the instrument will probably give the greatest service on the steam engine, it has a distinct advantage in the case of internal combustion engines as it

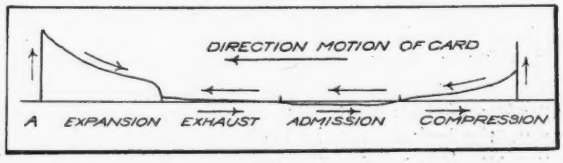


FIG. 1. CONTINUOUS INDICATOR CARD FOR GAS ENGINE

records a number of successive pressure conditions in the cylinder which could not be shown by an ordinary indicator card.

The horsepower can be found from this card by the planimeter. Referring to Fig. 1,—if the tracing point is run, from A say, in the direction shown by the arrows and back to A, the correct area for the work of the gas ignited at A will be found. The horsepower may be calculated from this area in the usual manner.

This method of taking cards, by the addition of a time stamp, which records periodically upon the indicator card, makes it possible to get the exact number of strokes per minute. It also indicates the number of explosions, which is a valuable notation in the case of misfiring. It will be noted that each event has one separate and distinct line which is a decided advantage in the case of internal combustion engines and it makes possible an analysis of the conditions which exist in the cylinder. The length of the card may be anything up to 50 ft., and it is therefore possible to indicate the engine for a considerable length of time continuously.

*Abstract of lecture delivered before the Internal Combustion Engineers' Association, at Chicago, January 13.

This naturally leads to the consideration of uniformity of rotation, for in this latter case it is necessary to have a continuous diagram of similar nature to that already considered.

The effect of piston pressure upon the crank shaft may be resolved into 2 forces, one acting tangentially to the crank pin circle, the other in the line of the crank arm, the result being motion in a circle about the crank shaft. This tangential pressure or force for a gas engine may be represented by the distance of the curve in Fig. 2 from the zero line and is positive or negative according to whether the piston is actually pushing the crank pin, or the crank pin, driven by the flywheel, is pushing the piston. Horizontal distances are not piston positions, but represent distances around the

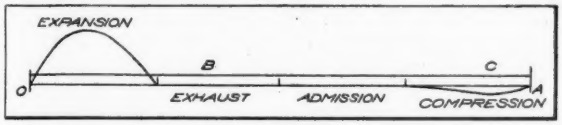


FIG. 2. DRIVING FORCE ON CRANK OF GAS ENGINE

crank pin circle measured from dead center. The conditions for a one-cylinder, single acting, 4-stroke cycle engine are shown in Fig. 2. Distances measured vertically from OA are tangential pressures. The distance of the line BC above OA indicates the mean tangential pressure on the crank pin circle. In the present case the modification of the tangential pressure due to the mass of the reciprocating parts is not considered because its total effect is zero for each stroke of the engine. Inspection of this figure shows clearly the necessity of employing a flywheel with this type of engine where closely uniform or even approximately uniform rotation is desired.

A very useful general rule for flywheels is that the change in revolutions per minute equals the number of successive non-working strokes multiplied by the horsepower being developed in the cylinder times 48,200,000, divided by the square of the number of revolutions per minute and by the square of the mean radius of the flywheel rim in feet and by the weight of the flywheel rim in pounds.*

This rule is approximate, but the percentage of error is not large. It assumes a constant demand on the engine for the particular horsepower under consideration.

Taking a small 4-cycle engine as an illustration, we will assume that the number of revolutions is 300, the maximum horsepower developed is 6, the weight of the flywheel rim is 500 lb., the radius of the flywheel is 20 in. or 1 2-3 ft. The accompanying table has been computed for different horsepower developed in the above described engine, showing the change in speed with hit or miss and throttling and cut-off governors. Suppose the engine to be developing 6, or its maximum horsepower, and for the sake of illustration that it is firing at every fourth stroke. In this case, since the engine is of the 4-stroke cycle type, there are 3 successive non-working strokes, the change in speed between explosions is, therefore, according to the above formula, 6.9 rev. for the hit or miss governor.

Again supposing the horsepower being developed is 5, we have 7 non-working strokes and the change in speed will be 12.7 rev., etc. For smaller horsepowers the successive number of non-working strokes increases, but in such amount as to keep the change in speed fairly constant and between 8 and 9. These values are based upon ideal governing for the power required.

In each of the above cases we refer to the hit or miss governor; where the throttling governor is employed, it will be noted that the number of successive non-working strokes for the different horsepowers is the same, the power developed by each explosion being varied according to the horsepower required from the engine. In this case the change in speed would necessarily be the same for the maximum capacity of the engine as for the hit or miss governor, but for powers smaller than the maximum the change in speed is less owing to the fact that the explosions occur at more frequent intervals than with the hit or miss governor—the changes being given in the table from which a comparison of the values of these types of governors can readily be made.

Suppose this engine should misfire while carrying its full load, we have then the successive number of non-working strokes increased from 3 to 7 and by substitution in the formula for flywheels we have 16.1 instead of 6.9 as the change in revolutions per minute between successive explosions. The regulation in this case, therefore, would be considerably less than half as good as when the explosions were regular. It will be noted here also that for either the hit or miss, or throttling type of governor at full load the change in revolution per minute due to misfiring is the same;

CHANGE IN R.P.M. FOR IDEAL GOVERNING

HP.	HIT OR MISS			THROTTLING OR CUT OFF	
	CHANGE IN R.P.M.	SUCCESSIVE MISFIRES	NON-WORKING STROKES	CHANGE IN R.P.M.	NON-WORKING STROKES
6	6.9	0	3	6.9	3
5	12.7	1	7	6.5	3
3	8.1	1	7	3.5	3
2	8.5	2	11	2.3	3
1.5	8.6	3	15	1.7	3
(1)	(8.8)	(5)	(23)	(1.2)	(3)

when less power is developed than the maximum capacity, however, the throttling governor has much the advantage in that the change in speed will not be so great as with the hit or miss type. To obtain the regulation of this engine at full load we would divide the change in r. p. m. by the average speed, or 6.9 divided by 300=0.023, giving 2.3% speed fluctuation. The speed fluctuation when the engine misfires would be 16.1 divided by 300, or 0.054, giving 5.4%, which could not be considered good.

By an examination of the formula for flywheels it will be observed that better regulation can be secured by increasing the speed of an engine or the radius of the flywheel or the weight of the flywheel, or if desired all three of these factors may be increased according to the judgment of the engineer.

In practice the change in speed per minute divided by the speed of the engine is considered poor when it gives 0.08 or above. For operating line shafts it is usual to employ regulation of 0.04 or better, for running generators for power purposes 0.01 is considered good practice. When the generator furnishes current for "good electric drives" regulation of 0.005 is necessary; for running alternating current generators in parallel it is necessary to employ regulation of 0.002 or better.

*Expressed as a formula this rule becomes:

$$\text{Change in r.p.m.} = \frac{K\ Hp}{N^2R^2W} \times 48{,}200{,}000 \text{ in which}$$

K=the number of successive nonworking strokes.
Hp=the horsepower being developed in the cylinder.
N=the average number of revolutions per minute.
R=the mean radius of the flywheel rim in feet.
W=the weight of the flywheel rim in pounds.

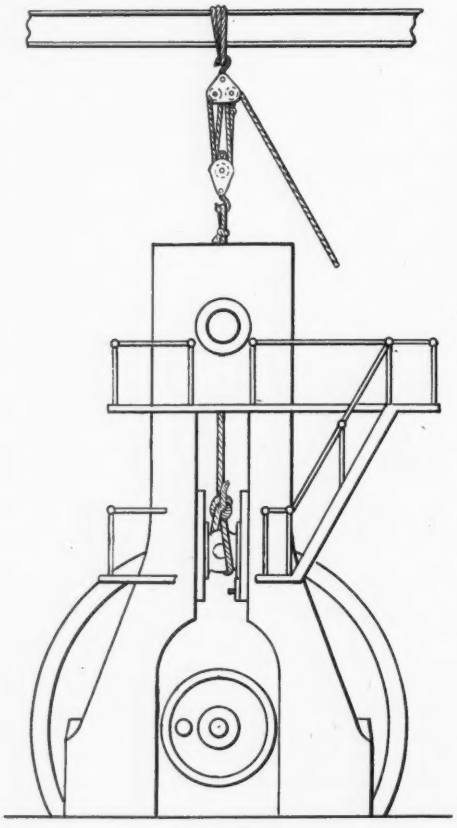
REMINISCENCES OF AN ERECTING ENGINEER VII

JACKETING CYLINDERS

By M. E. P.

WE have most of the engine assembled now but have done nothing so far about any of the piping. This is simple and it only needs a few words to make it clear. The exhaust pipe from the high-pressure cylinder to the receiver will be of cast iron and it should fit exactly if all the work has been done correctly. Cut the gaskets and paint the ends of the pipe with shellac and rub the gasket into close contact. Set the pipe away for a little while and let the shellac dry and there will be no trouble with placing your gaskets after the pipe is in position.

Do the same with all the piping where it is necessary and you will get along faster. Put on the throttle valve and let the steam fitters run the steam



PLACING THE CROSSHEAD

pipe to it. If the high-pressure cylinder is steam jacketed, run a pipe to the barrel of the cylinder and have a drip pipe run from it temporarily. The receiver has a heating coil and this is to be connected, but that is a job for the steam fitters. See that this is done so that you can get steam in the coil about the same time that the main steam connection is made. There is a by-pass connection so that live steam can be turned into the low-pressure cylinder and you will want this also.

Placing Crosshead and Piston

WHILE all of these connections are being made have the pistons put into the cylinders after the crossheads are up. The best way to handle the crossheads is to hang a tackle over the top of the cylinders and drop a rope through the stuffing boxes and fasten it to the crossheads and thus lift them into place. When the top of the guides are bolted on, leave the nuts off the lowest stud on each side and have a piece of ¼ in., flat steel, about 6 in. wide and long enough to extend across, drilled with a hole in each end so that it can be slipped over the 2 studs and then put the nuts on. Lower the crosshead and let it rest on this cross piece.

Now your crane will be wanted again to put in the pistons. There will be a hole or holes tapped in the piston rod or piston and there will be eye bolts sent with the engine that will fit these holes. Screw the eye bolts in solid and sling the piston from the crane so it will hang plumb. Do not have the rings in the piston. Lower it into the cylinder and as the rod comes through the stuffing box slip the gland onto the rod and then screw the crosshead lock nut on as far as it will go.

The McInosh & Seymour engines have a little recess or keyway cut in the rod and nut into which a small key is slipped when the nut is screwed back as far as possible. This key holds the nut from turning and a wrench is put on the nut to screw the rod into the crosshead. If there is not some such provision made it will be necessary to have the piston at the highest possible point and the follower plate will have to be removed and studs screwed into the holes where the follower plate bolts go and a bar used across them. This is in case the piston is riveted on the rod. If a nut is used to fasten the piston to the rod a wrench can be used on that. It is almost sure that there will be such a nut in large engines,—some of the smaller ones will have a riveted piston.

Put in the packing and set up the gland loosely and put the top cylinder head on. See that the valve chests are clean and well oiled with cylinder oil and graphite and put on the valve chest covers. In case of our engine these are flat plates and the joints have to be packed. There are several rolls of a ribbon packing sent with the engine and the way to use it is as follows. Lay the valve chest cover down flat with the joint up and paint the joint just inside the bolt holes with shellac, then starting at one corner lay a strip of the packing just inside the bolt holes on the shellac and put a flat piece of board on it and pile weights along its length; continue clear around the cover and where the strips of packing cross at the corner flatten it with a hammer. Let it set till the shellac is dry and put the covers in place and screw up the nuts medium tight only.

Applying Plaster

WHEN the covers are all on we have the cylinders steam tight and that is what we have been trying to do. The steam fitters have their connections

made and we have steam at the throttle to use when we want it. In case the high-pressure cylinder is steam jacketed we can turn steam through the jacket and heat the cylinder, otherwise we shall have to crack the throttle just a little and let the steam blow through the engine. Get it good and hot and in the meantime have all of the valve gear covered up with old cloths. Tuck waste or old rags into all of the openings around the cylinders so that none of the cement we are about to use can fall through and get onto the parts below. Get a mortar box and mix the asbestos plaster in it to a consistency as thick as can be conveniently handled. It must not be too wet or it will not stick well and will take a long time to dry.

There are several ways of applying the cement, one is to put it on with a trowel in thin coats, waiting between times for a coat to dry. Another way is to put on a first coat by throwing it at the cylinder in small gobs about as large as an English walnut.

An excellent way is to wrap the cylinder barrel with wire netting of about 1 in. mesh and throw the first coating at the cylinder in the same way as before mentioned only using somewhat larger handfuls of the cement. The last way is by far the best if a good, permanent job is wanted, but it costs a little more than either of the other ways. It is not only the cost of the wire screening but the time it takes to fit it to the cylinders. It wants to be put on smoothly and should have distance pieces under it so as to hold it out from the cylinder about ½ in.

It looks as if there were not much to choose between the first and second methods given for applying the plaster, but as a matter of fact there is a vast deal of difference in the results attained, If the plaster is laid on with a trowel and allowed to dry it will very likely flake off in spots when the second coat is put on it. If the plaster is thrown on in small bits it will be found to be very hard to pull off after it is bone dry and even the second has not much effect on the plaster so far as loosening it is concerned. It is well to throw on the second coating but after that the plaster is put on with a trowel and built up till it is about 1½ in. thick. An easy way to determine the thickness is to take a small bit of board and drive a nail through it allowing it to stick through the board the required length. The nail can be easily stuck into the plaster and the thickness gaged.

The throttle valve, exhaust pipe from the high-pressure cylinder, all valve chest covers except the low-pressure exhaust, steam pipe to the low-pressure cylinder and both top and bottom cylinder heads of the cylinders must be covered or packed with the plaster. If the receiver has not been plastered in the shop that will have to be done also. In that case it should be done before the receiver is put in place. It can be warmed by a temporary steam line and after the plaster is on the outside jacket is put back. The receiver is usually plastered in the shop so one has no trouble with that.

Of late years it has been quite common to send out covering for the cylinders in form of moulded slabs which are wired in place and the joints and corners filled with the plaster. This is much quicker to apply than the plaster. One important point in putting on the plaster is to see that each coat is dry before another is put on. In the case of the exhaust pipe from the high pressure cylinder to the receiver and the pipe from the receiver to the low-pressure cylinder, it is almost absolutely necessary to use the wire screening mentioned in order to get a good job.

The finishing coat of plaster should be as smooth and neat as possible and then cover it with a thin canvas cloth well stretched and the joints pasted, the whole finished with brass bands in the conventional manner. This will finish the work of plastering the engine and the valve gear and other coverings can be taken away and the necessary cleaning up done. Leave steam on until the plaster is thoroughly dry and hard. One last word about plastering, do not try to put plaster onto cold surfaces. It will not stick well and it will take an unduly long time to dry.

After the plaster is dry the steel jacketing is put on the cylinders. This is quite a long and tedious job but only requires patience. All the pieces are marked and will go in place without much difficulty. The relief valves may have to be taken off the cylinders to get the jackets back but this is not always necessary. Take off the cylinder heads and raise the pistons as far as possible and block the crossheads with the cross strips across the guides and take off the follower plates and put in the piston rings. The pistons must be centered in the cylinders by whatever means are provided and the follower plates put back and securely fastened.

Put the heads back on the cylinders and the top sides of the engine are about done. All that remains is to put on the lubricating devices and clean up. Let one man attend to this and turn your attention to the connecting rods. The easiest way to handle them is to sling a chain fall from the under side of the frame heads and hitch onto the rods at a point about 1/3 their length from the wrist pin end. Lift the rod after the upper half of the wristpin box and strap is in place on the crosshead and pull it into the strap and enter the strap bolt and key. Drive the key lightly and ease off on the tackle so you can swing the rod pendulum wise, driving the key all the while until you can feel it begin to pinch the pin.

Getting the Striking Points

NEXT put the crank-pin box and strap in place and drive the key until you feel it pinch and you are ready for the next step which is to find the striking points on the guides. It is not very satisfactory to try to find the top striking point by pulling the piston up with the chain block. You had best pull up as far as you can, until you think the piston has struck the head and then get a long lever under the crosshead and lower on the chain block a little. Then jump the lever down hard and you will hear the piston strike. Make lines on the cross-head and guides that coincide when the piston strikes and take the weight on the chain fall and lower the piston until it rests on the bottom head. Make a second line on the guide that will just match the line already on the crosshead and you have the striking points. The lines on the guides should be made light because you may have to change them later on.

Lift the piston and connecting rod and swing the rod in line with the crank-pin strap and lower the rod into its place and drive in the strap bolts. You are now about ready for the next step which will be the setting of the valves. All that remains to be done is to connect the upper ends of the main and auxiliary valve rods. These should have been left disconnected while the plastering was going on so that the valves could be moved by hand to supply steam to both cylinders from the top.

STEAM PIPE EFFICIENCY*

SOME REMARKABLE RESULTS OF RECENT TESTS

By H. J. Thorkelson

PIPE line losses are radiation, friction and condensation. The radiation depends largely upon the difference of temperatures between the pipe and the surrounding air, and can be reduced considerably by good insulation, such as magnesia covering or some similar insulating substance. The friction is an uncertain quantity and depends largely upon the pressure of the steam in the pipe, its velocity, and the size of the pipe. It can be reduced by using a pipe which is considerably larger than necessary, but, by increasing the pipe the radiation is also increased, and an economic mean must be used in order to secure the best results. The condensation in most cases is considerable and is an important item. There is some condensation even with superheated steam. It depends on friction and the difference of the temperature of the pipe and the steam itself.

Efficiencies at Various Loads

PRACTICAL information in regard to steam pipe line efficiency, especially where superheated steam is used, is lacking. Otto Berner of Berlin, Germany, gives some valuable information on the subject in regard to heat losses. He experimented with short pipes using both steam and hot water and determined heat losses. From his results a formula was derived for heat loss by using a combination of formulas for radiation as calculated by DuLong and Petit, and Peclet. However, in using any information given by him it must be remembered that the results were taken from a pipe only about 6 ft. long and superheated steam was not used.

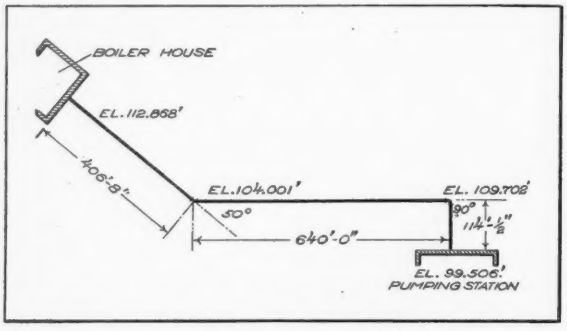


FIG. 1. PLAN OF LINE TESTED AT SCHLITZ BREWING CO.

The superheated steam pipe-line at the Jos. Schlitz Brewing Co. of Milwaukee, designed by J. C. White for D. W. Mead, consulting engineer, afforded excellent opportunities for obtaining information on superheated steam pipe-line efficiency. It was designed to carry steam at 120 lb. gage pressure and 250 deg. superheat, a distance of about 1,170 ft. (Fig. 1). Steam is used for operating 2 pumps, a De Laval steam turbine with centrifugal pumps of six million gallons capacity, and an Allis-Chalmers cross-compound heavy duty pump of the same capacity. Steam is taken from a battery of Babcock and Wilcox boilers, with superheaters, at about 100 deg. superheat. It is then arranged to pass through a Foster separately fired superheater and the temperature is raised to the desired degree of superheat.

The pipe line which was tested starts at the superheater and delivers the steam to a small receiver in the pumping station, and is so connected that steam can be taken either through the superheater or directly from the boilers. It is made of steel pipe 4 in. diameter and ¼ in. thick with welded flanged joints, which were closed by means of special steel gaskets, patented by Mr. White, the engineer in charge.

All turns in the pipe were made by easy bends of large radius so as to avoid any extra losses due to elbows. There were 2 bends, one of 51 deg. and one of 90 deg. The entire pipe had a total drop in elevation of about 15 ft. The pipe line was covered with 2½-in. 85 per cent magnesia covering and enclosed in a concrete tunnel 3 ft. high by 4 ft. wide, with a manhole situated at each bend.

The main object of testing the pipe was to determine efficiency, pressure efficiency, and the general performance of the line. Heat energy was tested at several points, especially at the ends, by taking readings of pressures and temperatures. Throttling calorimeters were used, but found unnecessary, as the steam was found superheated in all cases.

Thermometers, pressure gages, calorimeters and apparatus for weighing condensed water were all carefully calibrated before the test, according to methods in common and standard use, and with standards approved by the United States Bureau of Standards.

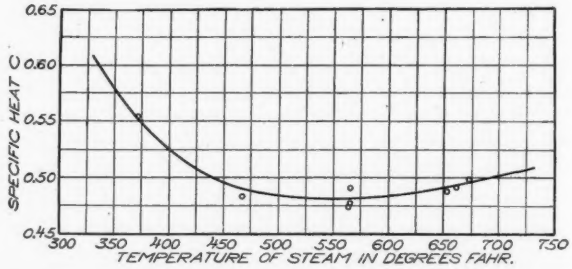


FIG. 2. VALUES OF SPECIFIC HEAT OF SUPERHEATED STEAM AT 99 LB. PRESSURE USED IN COMPUTATIONS

Tests, 4 in number, were run from 2 to 4 hr., readings being taken simultaneously at all 4 points, every 15 min. At the part where the steam pipe entered the pumping station, a gage and thermometer were placed, also arrangements were made for weighing all water taken from the trap which drained the separator, this water being the entire amount discharged from the pipe line.

Before these tests one was made to determine the condensation in the line at no load. In this case the water in the trap connected before the receiver at the pumping station was weighed for 2 hrs. As the line has a drop throughout its length the amount of condensation was accurately measured at this point.

The first 2 tests were conducted with the steam direct from the boilers without flowing through the separately fired superheater. In these tests the steam passed through the superheaters in the boilers and was heated to about 100 deg. superheat. All tests were run with the turbine alone in operation, its output being varied from 2.5 to 4.0 million gallons.

With the data taken it was possible to obtain the number of B. t. u. per hour contained in the steam passing any of the 4 points where instruments were used. By

*Abstracted from Bulletin 347 University of Wisconsin.

multiplying the number of pounds available steam passing any point per hour by the sum of the total heat of steam at that pressure and the specific heat at that temperature times the number of degrees superheated, the actual number of B. t. u. delivered by the steam past this point per hour was found. This value of B. t. u. was found at all 4 points and the drop due to condensation, friction and radiation was found for each length of straight pipe. The efficiency of the entire line was determined by dividing the actual number of B. t. u. delivered at the pumping station per hour by the actual number of B. t. u. delivered to pipe at the boiler house. The pressure loss was also determined for the line from pressure readings taken at the 4 points.

To find the available B. t. u. at any point, the difference between the actual temperature measured and the temperature corresponding to pressure was multiplied by the specific heat of superheated steam at the given temperature, and to this was added the latent heat for the given pressure. This gave the heat in a pound of steam and that was multiplied by the number of pounds of steam passing that point, per hour.

Values of specific heat of superheated steam were those given by Prof. Sydney A. Reeve, and a curve plotted for 99 lb. gage pressure. As all pressure values averaged about 100 lb., this is thought justifiable for lack of better information on the subject.

Average data from the 4 tests are given herewith:

Reading point—	Temperature.	Pressure.	Degrees Superheat.	Specific Heat.
Entering superheater	447.2	108	104.6	.496
Leaving superheater	421.4	104.5	80.9	.510
51 deg. Bend	382.1	106.3	40.5	.538
90 deg. Bend	363.8	101.2	25.5	.556
Pumping Station	362.7	101.1	24.5	.558

Condensed steam 7085.2 lb. Total per hour 3603.6 lb. Condensation in pipe 122.0 lb. Barometer 14.5 in.

Total 7207.2 lb. Average temperature of tunnel 72 deg. F.

Available B. t. u. entering superheater, 4,459,237.8 per hour. Available B. t. u. leaving superheater, 4,421,980 per hour. Available B. t. u. at 51 deg. bend, 4,331,408.6 per hour. Available B. t. u. at 90 deg bend, 4,254,636.6 per hour. Available B. t. u. at pumping station, 4,246,749 per hour.

$$\text{Equivalent horsepower delivered equals} \frac{778 \times 4{,}246{,}749}{33000 \times 60}$$

equals 1668.

B. t. u. total loss in pipe equals 4,421,980—4,246,749 equals 175,228.5 per hour. B. t. u. condensation loss equals $122 \div 2 \times (1185.5 + .534 \times 50)$ equals 73,932 per hour. B. t. u. radiation and friction loss equals 175,228.5 —73,932 equals 101,296.5 per hour.

Total efficiency of pipe equals 4,246,749÷4,421,980 equals 96.0 per cent.

For the 3-hr. test (without superheater). Total efficiency of pipe equals 99.52 per cent.

Four hour test (with superheater). Total efficiency of pipe equals 94.5 per cent.

Five hour test (with superheater). Total efficiency of pipe equals 95.51 per cent.

The results of the test on the superheated pipe-line were very satisfactory. The efficiency seems a trifle high for a line of this length, but this result can be accounted for by the unusually good construction of the line. The tests show that a moderate degree of superheat as used in the first 2 tests gave the best results since the radiation and friction are not large and the condensation is moderate. When high superheat was used, the condensation was reduced to a minimum and the radiation and friction became extremely large, giving a corresponding greater total loss.

The average per cent drop in pressure of the steam in the line was about 5. This factor is low for the reason that the pipe line was designed somewhat larger than absolutely necessary and the drop in pressure is necessarily reduced. The pressure reading of the steam leaving the superheater is low, due to a sudden turn in the pipe increasing the velocity and decreasing the pressure of the steam slightly. The average total loss in B. t. u.

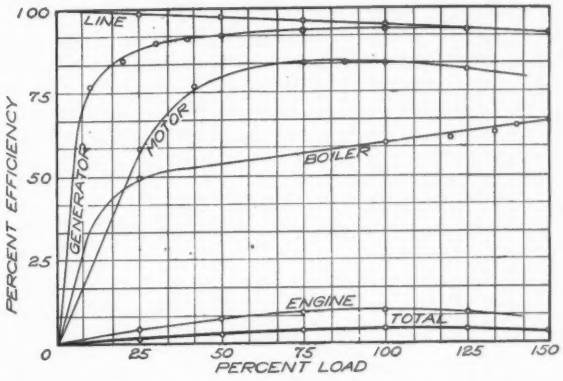


FIG. 3. EFFICIENCY CURVES FOR BOILER ENGINE, GENERATOR, LINE AND MOTOR, AND COMBINED PLANT EFFICIENCY

of the 4 tests is about 194,000 B. t. u. per hour, or about 162 B. t. u. per square foot of pipe surface per hour. The average drop in superheat for the first 2 tests when the Foster superheater was not used was about 57 deg., or about 1 deg. F. for every 20 ft. length of pipe. This is considerably better than was estimated in the design. On the other hand, the drop in degree superheat in the last 2 runs averaged 133 deg., showing a loss of 1 deg. for every 9 ft. length of pipe. This value is about what was expected with the high superheat.

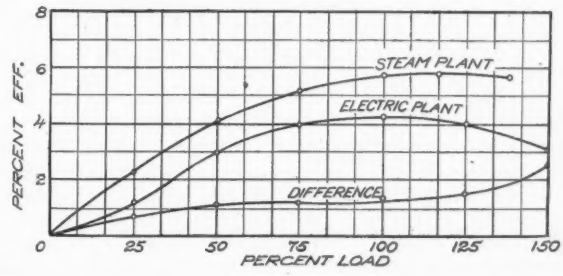


FIG. 4. COMPARISON OF PLANT EFFICIENCY WITH STEAM LINE AND WITH ELECTRIC TRANSMISSION

The normal load on the pipe line was determined by using a velocity of steam of 6000 ft. a min. and multiplying by the area of the pipe in square feet. This value gives the amount of steam delivered by the pipe in cubic feet per minute and by multiplying by 60 and dividing by 3.5 (specific volume of steam under the given conditions) the number of pounds of steam passing through the pipe per hour is determined:

$6000 = (4)^2 \times 0.7854 \times 60 \div (144 \times 3.5) = 9000$ lb. an hr.

Using the average number of pounds of steam used in the 4 tests—3600 lb. an hour—and knowing the average efficiency, 1 point on an efficiency curve is found. Since this point gives the efficiency at 40 per cent load as about

95 per cent the efficiency at full load is estimated to be about 96 or 97 per cent.

Efficiency curves for steam pipe lines are highly desired, and the engineering department of the University of Wisconsin is planning to conduct other experiments on steam pipe lines of various designs, using saturated steam in order to gather data from which to construct such curves. The remarkable results given above show that it is possible to get very economical transmission of energy by means of properly designed and insulated steam pipes.

Very instructive comparisons may be made of a system of steam transmission with an electric system for transmitting energy. For example, the selection of a steam pipe line in the case of the pumping plant for the Schlitz Brewing Co. in preference to an electric system is amply justified by drawing a combined efficiency curve for the steam system, assuming a separate boiler plant with a pipe line connecting 2 steam driven pumps at the

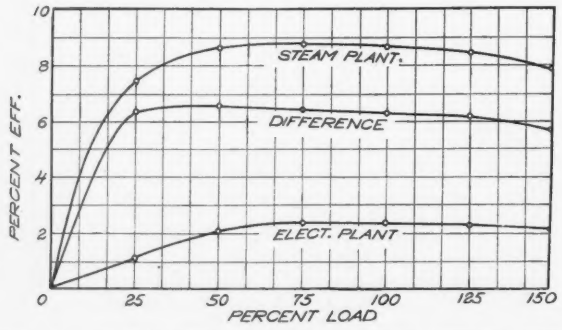


FIG. 5. COMPARISON OF TRANSMISSION SYSTEM EFFICIENCY, STEAM AND ELECTRIC CONDITIONS AS STATED IN TEXT

pumping station, and comparing this with a combined efficiency curve for a plant having a boiler, engine and electric generator at the power plant and electric transmission from there to the station and motor driven pumps at the pumping station. This comparison is made in Fig. 3, which shows remarkable advantages of the steam equipment, particularly at full loads and above.

A comparison which would more nearly represent the actual conditions of the problem met by Messrs. Mead and White would be to assume 2 possible installations, one an electric installation taking current from a generator and transmitting through a line to a motor. Under the probable conditions the motor load would be only part of the generator load, and if it is assumed that the boiler efficiency under the various loads at the pump station remains at a constant quantity, say 65 per cent (this assumption is justified because of the large steam boiler plant installed), the engine efficiency at a constant quantity of say 7 per cent and a generator at a constant effi-efficiency curve for a plant having a boiler, engine and motor will vary according to load, the total efficiency of this system would be as indicated in Fig. 4. This is to be compared with a steam pump of high economy connected by a steam pipe line to this boiler plant operating at a constant efficiency of 65 per cent and giving a total efficiency as indicated in Fig. 4. The difference between these 2 systems is seen to be very great, due to the fewer changes of energy required and to the high pipe line efficiency possible. The comparisons given above illustrate the value of drawing efficiency curves for the separate elements of a power plant and a combined efficiency curve in order that the engineer may be able to select proper apparatus to fit the conditions of his problem.

POINTERS ON PUMPS

PIPING AND CYLINDER RULES

By C. F. Swingle

WHEN measuring lengths of pipe preparatory to cutting, measure the distance between centers of fittings, or flange joints. From this length substract one-half the length of each fitting, provided fittings are not the same at each end, and add length of pipe that enters the fittings.

When fittings are the same at both ends, subtract the length of one fitting, and add the length of pipe entering both fittings.

The Practical Tables give the distances that the different sized pipes in ordinary use enter fittings.

For measuring 45-deg. elbows multiply the horizontal distance between centers of vertical pipes by the constant 1.414. This gives the distance measured at an angle of 45 deg. between centers of fittings. Then make the same deductions, and additions as in the other cases.

All piping expands when heated. If confined between walls, or solids, either the walls must give way, or the piping will be distorted. A U-shaped expansion loop is a good preventive of excessive strains on piping, and should be used where there is liability of such strains being encountered.

Pointers on Pumps

THE best types of valves to use in piping for pumps are globe valves for steam and gate valves for water. Before the steam pipe for a pump is connected it should be thoroughly blown out with steam, otherwise any dirt or rubbish which might be in the pipe will be carried into the steam cylinders and cut the valves and piston. When a pump is first put in operation, great care should be exercised in drawing up all joints as a precaution against blowing out of gaskets.

Suction

SPECIAL attention should be given to the suction pipe to see that every joint in it is air tight, as a very small air leak will tend to destroy the vacuum, and thus prevent the suction chamber of the pump from properly filling at each stroke.

A suction chamber screwed upright into the suction pipe close to the pump will be found useful, especially when the suction pipe is long, and the lift high, or when the pump is run at a high speed. As far as possible, the use of valves, and elbows (with the exception of the foot valve) should be avoided in the suction pipe. It should be as straight as possible because bends, valves and elbows materially increase the friction of the water flowing to the pump.

Care should be taken to insure that the lower end of the suction pipe will clear of mud and sand, and that the water shall have a free and unobstructed flow into it.

Cylinders

IN packing the water piston or plunger, the packing should be so adjusted as to permit the plunger or piston being readily moved to either end of the cylinder by hand. To find the number of gallons raised in 1 min. by a pump, running at 100 ft. of piston speed per minute, which is the ordinary speed for pumps, square the diameter of the water cylinder in inches, and multiply by 4.

To find the diameter of water cylinder required to move a given number of gallons per minute, divide number of gallons by 4, then extract the square root of the quotient, and the result will be the diameter of water cylinder in inches.

To find the horsepower necessary to raise water to a given height, multiply the number of gallons per minute by the head in feet and divide the product by 3960.

Head in feet means the vertical distance in feet from surface of supply to surface of water in the discharge tank or reservoir.

The area of the steam piston multiplied by the steam pressure gives the total amount of pressure that can be exerted.

The area of the water piston multiplied by the water pressure gives the total resistance.

A margin must be made between the total steam pressure and the total resistance to move the piston at the required speed. This margin should be from 20 to 40 per cent, according to the speed and other conditions.

A gallon of water (U. S. standard) weighs 8 1/3 lb. and contains 231 cu. in. A cubic foot of water weighs 62.5 lb., and contains 1728 cu. in., or 7½ gal. If it is desired to ascertain the proportionate areas of steam, and water cylinders for a pump required for a given service, multiply the given area of the pump cylinder by the resistance on the piston in pounds per square inch, and divide the product by the available steam pressure in pounds per square inch. This product equals the area of the steam cylinder, to which 25 per cent should be added to overcome friction. The resistance of friction in the flow of water through pipes of uniform diameter is independent of the pressure, and increases directly as the length, and square of the velocity of flow, and inversely as the diameter of the pipe.

IN THE OPERATION of steam turbines it is recognized that as the degree of superheating is increased the steam consumption of the prime mover is proportionately decreased. Other factors which are affected in obtaining this superheat are generally overlooked and the idea is more or less prevalent that the plant efficiency steadily increases with the superheat. A study of the conditions, however, demonstrates that the improvement ceases at about 100 deg. superheat. In some types of turbines a high degree of superheat is essential to delay the due point and obviate the effect of moist steam. Westinghouse Diary.

TURBINE DRIVEN CENTRIFUGAL PUMPS FOR POWER HOUSE USES

By H. Ross Callaway

INCREASING use of centrifugal pumps for a wide range of uses has called particular attention to the question of a proper means of driving them in order to obtain the most efficient service. The flexibility of the centrifugal pump calls for a flexible type of prime mover to enable it to develop its highest efficiency, and among the various means available one widely applicable is the steam turbine. It is essential that a successful centrifugal pump drive should embody simplicity, wide range of speed, compactness and ease of control, as well as inherent ruggedness to enable it to withstand the rough service which often falls to this type of unit.

In the power house, space considerations are often highly important and the compactness of the turbine-driven centrifugal is an added argument in its favor; also the fact that high rate speeds and consequently smaller sizes may be used in many cases gives it a great advantage.

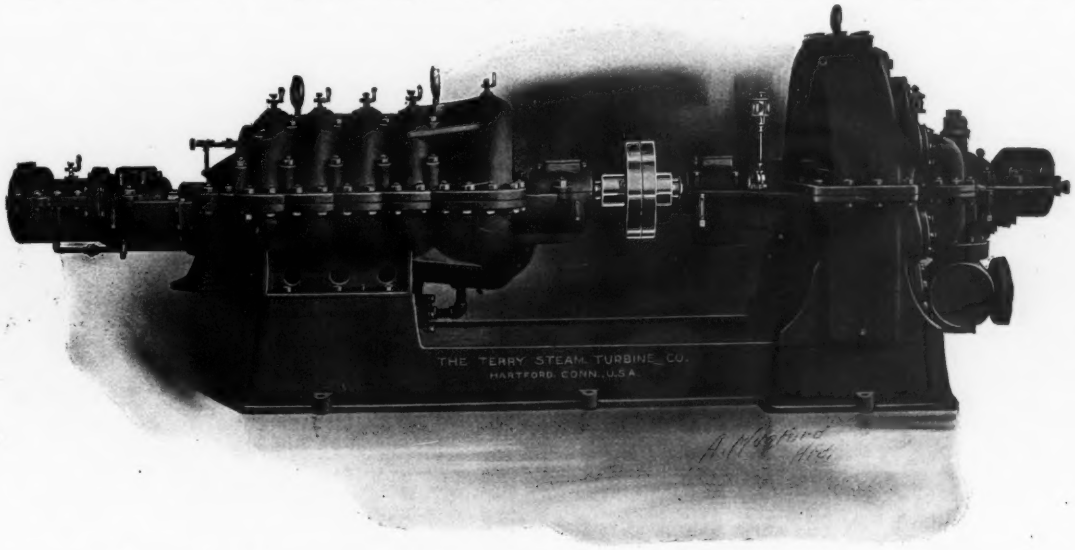


FIG. 1. 5 STAGE PLATT CENTRIFUGAL PUMP DRIVEN BY TERRY STEAM TURBINE FOR BOILER FEEDING

Although the thermal efficiency of the turbine as a prime mover compares favorably with the reciprocating engine, this feature is rarely of importance because of the extensive use of exhaust steam from auxiliaries for heating the feed water, and exhaust steam from the turbine used in an open heater carries no oil over to the boilers.

Where large condensing units are employed and the basement space is limited, the small dimensions of the turbine driven pump enable it to be placed in almost any available place, very often directly under the condenser itself. This is, of course, particularly true of hot well pumps, but in many cases the circulating pumps have also been arranged in this fashion.

Although the field for these units in power house design is broad, there are 2 main uses to which they are particularly applicable—in connection with condensers and for boiler feeding. For circulating the water for a surface condenser, the pump should be able to handle

large quantities of water at comparatively low head and medium speeds. The large capacity of a turbine driven centrifugal and its small size are important advantages for this class of service. The operation is generally steady, as the rate of flow of the condensing water is never altered, regardless of the load on the main unit. A steam turbine with its close regulation is well adapted to run satisfactorily under this steady load with practically no attention whatsoever beyond occasional oiling. Furthermore, on sudden demand, the turbine will start perfectly cold and thus get the circulating pump into action quickly.

Centrifugal wet vacuum pumps are becoming much more common of late since the troubles which cropped

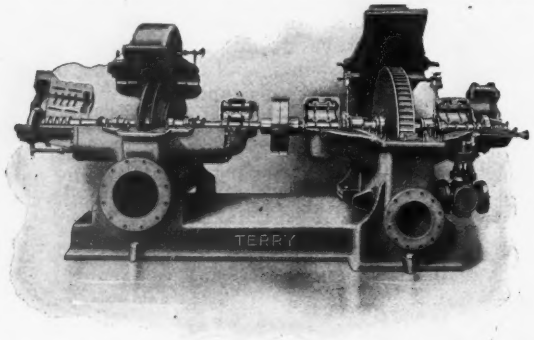


FIG. 2. SINGLE STAGE PUMP AND TURBINE WITH COVERS LIFTED

out in the first installations of this character have been practically remedied. If a sufficient suction head is available on a pump, say 3 or 4 ft., care is taken to insure tightness, and a discharge head of 25 to 30 ft. is provided, these units will operate satisfactorily under all conditions of load.

Rapid fluctuations often experienced on the main units of a central station cause rapid changes in the total water rate and consequent speeding up and slowing down of the wet vacuum pump. The flexibility of the direct turbine driven centrifugal is of vast importance in such cases. By the use of a float valve, operated by a float in the condenser hot well, the action of these units can be

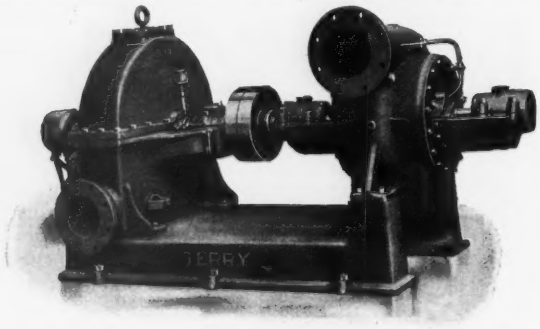


FIG. 3. SINGLE STAGE CONDENSER PUMP OUTFIT

made absolutely automatic and there is no possibility of the hot well being sucked dry. The only attention required is occasional oiling. A turn of the throttle valve stops the pump and it is ready to start up again without any preliminary work whenever the throttle is reopened.

One of the accompanying illustrations shows a 5-stage centrifugal pump manufactured by the Platt Iron Works, for boiler feed purposes, direct connected to a Terry Steam Turbine. This particular unit is one of eight installed in a large power house in which there are no reciprocating boiler feed pumps at all, reliance having been placed entirely on the newer type. This is a comparatively recent departure from established practice that has been entirely justified by the results obtained. The ease of handling such units as these recommends them to the power plant man and the ever-ready quality is of particular importance in plants liable to sudden peaks.

Centrifugal pumps for feeding boilers are growing rapidly in favor, high pressures being obtained by the multiplication of stages and capacity by high speeds. Pressures up to 270 lb. have been handled by 5-stage pumps with a capacity of anywhere from 500 to 1500 gal. per minute.

Freedom from pulsations makes it possible to meter the boiler supply with accuracy, the Venturi tube, for example, giving results within 1 per cent of those obtained by means of tank scales.

If the boiler feed water is poor but small damage is done to the centrifugal pump. The usual type of rotor for handling boiler feed water is of bronze and corrosion is practically unknown. Foreign matter will usually go through a centrifugal without any trouble, and hot water can be handled with no more bad effects than cold. Both turbine and pump being so simple in design, wearing parts are reduced to a minimum and the cost for repairs, oiling and attendance consequently very much diminished.

The centrifugal pump is now accepted as a standard design for fire pumps, many large installations of this

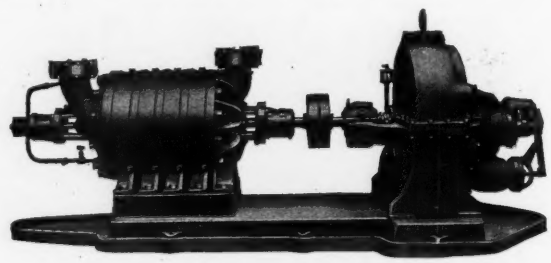


FIG. 4. STAGE UNIT FOR FIRE SYSTEM

character having been made within the last few years. Fire service is always emergency service and this means ability to start quickly at any time. When the pump is properly primed—a very simple matter to provide for—it is only necessary to open the throttle valve of the turbine to get results. To obtain full rated pressure and capacity it is merely a question of getting up to rated speed, and this the steam turbine accomplishes quickly.

Various methods of priming the pumps are in use, the popular method in power plant practice being to place a foot valve on the end of the intake pipe, this insuring that the pump will be flooded when it is desired to start up. Flap valves placed in the discharge line and steam injectors are another means of preventing the pump becoming air-bound. Aside from this simple protection there is practically nothing to think about in connection with these units for any service and their wide application proves conclusively the soundness of the theories upon which they are based.

THE MASTER MECHANIC of a Rhode Island trolley company has done away with the troubles arising from the collection of grit and dust on the teeth of the motor pinions and the compressor gears, by placing felt shields on the motor cases and piping the compressor air from the car roof. This means may help engineer in a machine shop employing compressed air to make his gears wear longer.

PREVENTION OF SMOKE IN CHICAGO

IN an interesting article recently published, City Smoke Inspector Paul P. Bird tells of the organization of his department and of the means at present adopted for preventing smoke. While the department has been working in the past to do this it has been largely in the position of a monitor warning when there were offenses against the smoke ordinances. Now the attempt is to conduct an engineering department which shall assist in planning and providing means to avoid making smoke.

The size of the task is seen from the fact that the city covers 195 sq. mi., a large part of it being engaged in manufacturing and the rest having flat buildings, hotels, office buildings and other places where large quantities of coal are burned. Adding to the difficulty is 2100 mi. of railroad track on which 1500 steam locomotives are working, all of them burning soft coal. The total amount of soft coal burned in the city during the year is approximately 10,000,000 tons, which, improperly handled, can make a right smart amount of smoke.

Mr. Bird believes that soft coal from Illinois and Indiana fields is the natural fuel of Chicago and should be used, but that this can be burned economically and without smoke, as the working of thousands of chimneys within the city proves; but the task of watching all the stacks in this large area and on these miles of railroad is enormous, and considering that there are 34 persons employed in the department, part of whom are engaged in giving assistance in the planning of plants and issuing of permits, it is not strange that some smoking chimneys are not seen by the inspectors. The other duties of the board leave 14 men available as observers, to watch 17,000 smoke stacks.

In his article Mr. Bird gives a history of the effort in Chicago to suppress the smoke nuisance, and of the appointment of a commission to superintend the work, and it should be said, to the credit of this commission, that it is made up of business men and manufacturers having power plants of their own, who, where smoke has been made in their own plants, have fined themselves, paid the penalty, and gone back to remedy the trouble.

In addition to this commission, which has in charge the general work of the department and advises the mayor as to the conduct of this department and the appointment of its employes, there is an advisory board of 3 engineers to give advice on technical and engineering matters.

When a plant is to be built the department advises as to methods which may be employed for smoke prevention. If the owner of the plant feels that this advice may not be right or that the expense required is too large, the advisory board is called in and goes over the plans. But a steam plant for the burning of soft coal may not be built without getting the approval of the smoke inspector and his permit for the work.

Thus the smoke commission has charge of the work of the department and stands as a representative of the public towards the department on all questions of general policy. Appeal may be made from the rulings of the department to the commission in the certainty that the final ruling will be fair and just, and appeal may be made to the board of advisory engineers on questions of engineering, with the knowledge that the best men in the city are available to pass upon these points. At all times the department is ready to work with owners, engineers or firemen to advise about apparatus, methods of firing, and details which may assist in avoiding smoke making.

An added advantage which comes to the owner of the plant is that in most cases, with a plant properly built and properly handled to avoid smoke making, better economy is secured in burning the coal than would otherwise have been obtained and frequently by the adoption of these methods a cheaper coal can be burned without smoke making than would have been possible with the furnace which the owner might otherwise have installed.

For the benefit of the fireman who is working to comply with the ordinance, deputy smoke inspectors, who are practical operating engineers, are employed to go from plant to plant where there is trouble, study the conditions at the plant and work with the fireman, suggesting methods of firing, possible changes in fuel, or changes in the furnace, which may be of assistance in reaching the desired end. Needless to say, with the small working force available the city is not yet free from smoke, but there is a considerable improvement noticeable, and the smoke ordinance as it now stands and as it is being administered, has the approval of reasonable plant owners and is securing the co-operation of those who formerly opposed the anti-smoke movement.

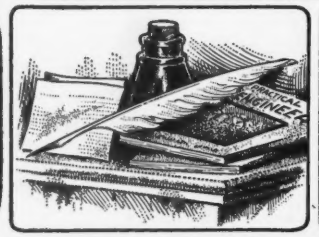
A LARGE PUMPING CONTRACT

ONE of the largest contracts for pumping machinery ever placed has just been awarded to the Alberger Pump Co. of New York City by the Bureau of Yards and Docks, the total sum involved being slightly over $323,000.

The contract covers pumping equipment for the 3 new dry docks to be constructed by the Government at New York, Puget Sound and Pearl Harbor Navy Yards, and includes all told 11 54-in. vertical volute pumps, each direct connected to a 550-hp. induction motor, and 7 15-in. vertical volute drainage pumps, each direct connected to an 85-hp. induction motor; also all necessary suction and discharge piping, electrically operated gate valves for the same and all electrical controlling apparatus for the motors. Three of the 54-in. units will be located at New York, while 4 of these units are required for each of the other docks.

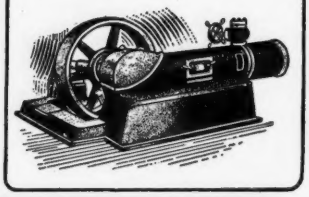
Each unit is required to operate against a static head, varying from zero when the dock is full to a maximum of 42 to 44 ft. when the dock is completely empty, while operating at a constant speed of 219 r. p. m. without exceeding the rated horsepower of the motor at any point. In addition to this, each pump is required to maintain an average capacity of 66,000 gal. per min. when emptying the dock of the keel blocks, the static head varying from zero to 32 or 34 ft. Under these conditions the contractor has guaranteed an average efficiency of 45 per cent for New York and Pearl Harbor and 46 per cent for Puget Sound, these efficiencies being the ratio of the actual useful work in pumping the docks to the electrical input to the motors, and consequently includes all losses in the motors, pumps and piping. To meet these average efficiencies it is necessary for the pumps, themselves, to reach a maximum efficiency of nearly 80 per cent.

In addition to obtaining a high efficiency, the other characteristics of the pump have to be very carefully determined in order to meet the special conditions involved in this class of work.



Letters from Engineers

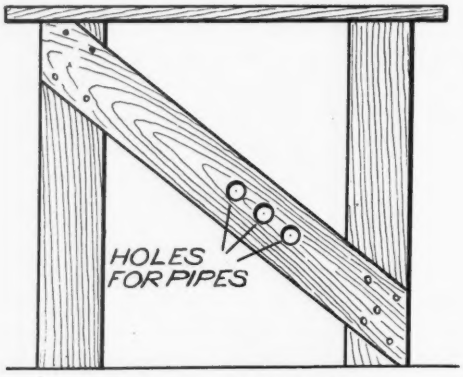
Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



BENDING PIPE

IN November issue I notice that J. H. Smith gives some very good points on bending pipes of various sizes. While his ideas are fine, I believe that the simplest, quietest and easiest way to do a job and do it well, is the best. Having seen a few bends which mate very well with those in his sketch I would say that the one which is flattened at the bend was caused by the pipe being heated, and the other was heated and then bent over some corner of an anvil or something of that structure.

I have been very successful in making bends of piping of 1 in. and smaller sizes in the following manner: With a brace and bit bore a hole, about ½ in. larger in diameter than the pipe to be bent, in a soft pine timber which is made solid in the building, tank bracing or foundation, insert the pipe to the



OUTFIT FOR BENDING PIPE

point at which the bend is desired and make the bend by pulling slowly to one side moving the pipe in and out a little after each pull. It will be seen that the soft pine will give way to some extent and will not crush the pipe which, being cold, will not flatten at the outside or back of bend. The main point is, don't try to make the bend in 1 or 2 pulls.

The sketch shows all the outfit I have used to make bends of those sizes. The timber which has the holes bored for the pipes is part of the bracing in a tank platform and is 3 in. thick by 12 in. wide.

B. F. Hartley.

NEW VALVES

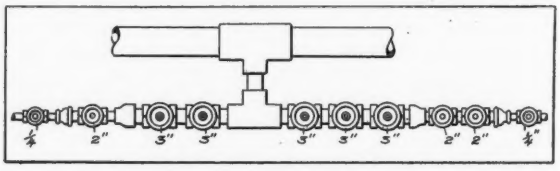
SOME time ago the chief electrician called my attention to a valve, 2½ in. globe, that was closed, but was still leaking enough steam to show on a small pocket mirror. The valve had been put into the pipe line but the day before.

I cut the steam off of the line, took off the valve and cleaned off both seats thoroughly. I put the valve back again and gave it another trial, but to my amazement I discovered that I had improved it but very little by my first operation, so then removed the valve again, cleaned both seats thoroughly and began to do some experimenting.

I put a second-hand valve on in place of the new one, the former had first been thoroughly ground with emery dust and plenty of oil. The question arose in my mind "Why does a new valve leak so soon, and why does this old one hold up so well?" I took a powerful microscope and carefully examined both seats of the new valve and found to my astonishment that they were full of very small grooves running at right angles to the seat and concluded that it was through them that the steam escaped.

I at once made provisions for testing new valves. At a connection on the main steam header I attached a 3-in. tee and to this some short nipples and 2 or 3 extra 3-in. valves, fitted them up and connected up on the tee in both directions. I reduced these to 2 in. and put a few of them on and kept on doing this until I had a few of each size on down to ¼ in.

The valves should all be cleaned on both seats and packed thoroughly and closed moderately tight by hand. When I want a valve now I close the one nearest to the header and remove whichever size I want



VALVE TESTING ARRANGEMENT

and return the rest and open the valve again. I find that after putting valves through this test the chemical action of steam on brass at the temperature of steam at 130 lb. hardens it to such an extent that steam will not leak through when put into actual service.

If it does leak the least bit it will allow ample opportunity to remedy it before putting it into actual service. This method I have found repays well for the time of erecting this testing arrangement, in regrinding and sometimes removing valves entirely from the line because they leaked. Russell R. Ux.

WATER HAMMER AND PRIMING

ON page 702 of the November issue F. T. describes the method used to prevent priming and water hammer, and according to his sketch the steam outlet is at the front end of the drum and there is no dry pipe or baffle plate in the drum, also the flame plates or baffles are placed vertically in the tubes so that the fire travels across the tubes instead of lengthwise with them.

Cause of priming is, I believe, the draft of the steam outlet directly over the front header from which the mixture of water and steam is rising at high velocity and is drawn directly into the steam pipe. This was further aided by the feed water being pumped into the steam space because after turning the pipe down to the proper position, he says the priming and water hammer still continued. This shows that the feed pipe was not the cause of it. But when he changed it to discharge directly into the water rising from the header he mingled the cold water directly with the hottest water of the boiler.

This is because the hottest fire is in the front 1/3 of the tube length and the direction of the flow of water is from front to back in the drum, down through the rear header, from here to front through the tubes and up the front header in a mixture of steam and water; then the cooler water strikes it and condenses a portion of the steam, thus acting as a baffle and retarding its velocity in the same manner that a little cold water will momentarily stop the violent ebulition of the water in a kettle.

The proper remedy in this case is the use of a baffle plate between the rising water and the steam outlet, also a dry pipe arranged to take the steam from the top side as I believe is the custom in nearly all types of water-tube boilers. The baffle plate is in sections and bolted together inside and should extend across the drum, about 16 in. high in the center and extending from the front head about 2 ft. back of the header outlet or water leg. This will direct the water back and stop the priming.

Also a dry pipe the same size as the steam pipe and about 2/3 the length of the drum should be made with an ell on one end and the other end capped; a piece of old pipe will do as well as any. Then drill the top side full of ⅜-in. holes the full length and about ¼ the circumference. Also a row of ⅜-in. holes in the bottom for drainage. Fasten this in place by braces or legs from each side of the drum, or by brackets fastened to the top of the drum with cap screws or rivets.

The feed pipe, which I think caused the noise but not the priming, should be made with bends instead of ells and extend back of the second flame plate into the coolest part of the boiler using a pipe 2 sizes larger than the feed pipe inlet.

The reason for the noise I believe to be the comparatively cold water at high velocity due to small pipe or a pipe partly filled with scale coming in contact with water at a very high temperature; at least the above has been my experience, and the reason the noise stopped with the last change was because of a free outlet. But that would reduce the capacity of the boiler as the cold water strikes the mixture of steam and water. J. C. Hawkins.

WHEN THE AUTOMATIC DID NOT WORK

WE have here a hardwood flooring plant driven by a 14 by 24-in. automatic cutoff engine with riding cutoff valve, and ever since we started up last April this engine has given trouble, some part of the automatic governor breaking about every week. Two weeks ago we decided that a throttling governor would overcome our trouble and put in a Gardner governor, throwing out the automatic and the riding cutoff valve. Since that time we have had steadier motion, no breakdowns and burn only about half our shavings, whereas before we burned all the shavings in the daytime and had to furnish other fuel for the night. We found after installing the new governor that there was about 3/16 in. lead on this engine, which was running at 98 revolutions. Was that amount correct? We carry 100 lb. steam pressure and exhaust into the dry kiln with back pressure set at 4 or 5 lb. I am interested to know what other readers think about this amount of lead. B. C. H.

TROUBLE WITH METALLIC PACKING

WE experienced a great deal of difficulty in keeping the metallic packing around our 3½-in. piston rod from leaking. The original condition is shown in Fig. 1. After studying the conditions we dressed off

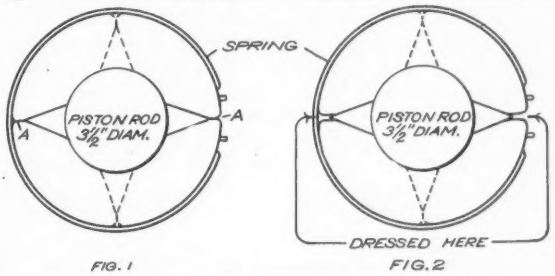
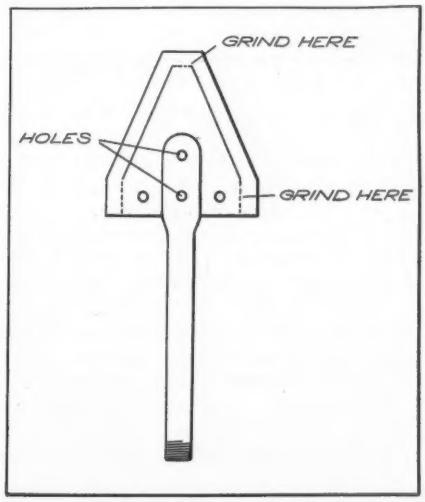


FIG. 1. METALLIC PACKING WHICH LEAKED
FIG. 2. METHOD USED TO OVERCOME LEAK

the points A, Fig. 1, with a file, to make them appear as in Fig. 2. After this change was made no trouble whatever has been experienced with leaky packing and the engine has now been running for over a year. W. D.

SCALE REMOVING TOOL

TAKE a plain sickle section, such as used in mowers, punch or drill 2 holes as indicated, then take a piece of ⅜ in. pipe about 6 or 8 in. long, hammer 1 end flat, also drill 2 holes and rivet the sickle section to the pipe. Next grind the point and sides to the same taper or bevel.



HOME-MADE SCALE REMOVER

Now, if you go into your boiler the way I do, you will have to attach another piece of pipe, say 12 to 18 in. long, according to size of your boiler; you also may attach a long piece of pipe and do some work from the outside. H. Klundt.

BELT LACING

IN answer to H. C. G.'s inquiry in the November issue regarding belt lacing, I would say that for upwards of 18 yr. I have not used any other than Kerr's patent wire lacing. I am engineer at a large coffin and casket factory where a great many fast running wood working machines are in use and where the belts have very severe usage and all of the belts are laced with wire lacing, which practically makes an endless belt and makes the machines run as smooth as possible.

There are 3 grades of wire for belt lacing, No. 1 for wide, heavy belts; No. 2 for medium width double, and No. 3 for small and single belts. The holes in the belts should be only sufficiently large for the wire to pass through nicely. The holes for light belts should be punched about ¼ in. from the end and about ½ in. apart; for heavy belts the holes should be punched about ⅜ in. from the ends and about 10 holes to 4 in. width of belt.

In cutting the wire so as not to have any waste, for single belts, use 7 times the width of the belt for the lacing. Thus, if the belt is 7 in. wide,

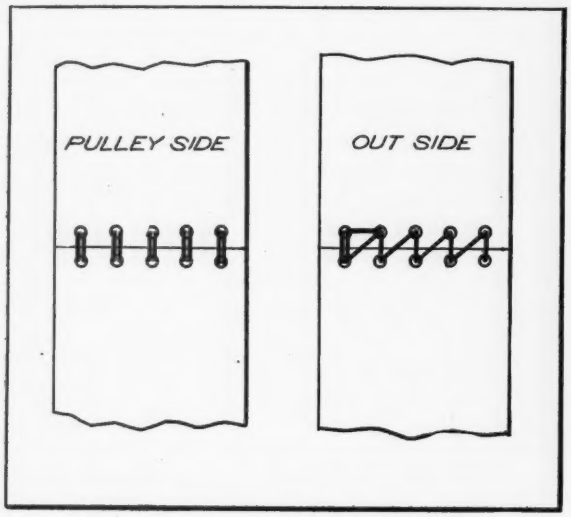


FIG. 1. METHOD OF LACING WITH WIRE

49 in. of wire would be required. For double belts, the length of wire required is 8 times the width of the belt. In commencing to lace a belt see that the holes come opposite each other. If the belt is very wide, requiring, say, 40 holes, cut the wire in 2 parts and commence at the tenth hole and work both ways, pulling the wire tight with a pair of pliers from the end of the wire, being careful that the wire does not get crossed. To fasten the wire, all that has to be done is to cross over on the top side and pass through hole to the pulley side, pull up tight and cut off within ¼ in. of the belt and turn down. When the lacing is finished, get a smooth hammer and pound down the lacing until it is imbedded into the leather and you will have as fine an endless belt as anyone would wish to see.

On my main belt there are 2 joints, all laced with wire lacing and 2 of the joints have been running for upwards of 5 yr. The other joint is the one that I cut when I want to take up the slack. It is a very heavy double leather belt, 18 in. wide, 65 ft. long, running from a 96-in. pulley to one of 32 in. diameter.

William Downes.

BEARINGS AND BELTING

ARTICLE "Finishing a Bearing" by Herbert Charles, page 721, November issue of the paper, attracted my attention, and I would like to say that I, too, had an experience very much like that referred to in the article and can vouch for the efficacy of Sapolio in producing a cool running bearing. In my case, water was used at first instead of oil. One of the bearings of a line of shafting 12 in. diameter and 24 in. in length began to heat to an uncomfortable degree, and although extra oil was supplied the heating was not checked. The cap or binder was removed and the journal showed just where the hard spots were by rings of a deep blue color about an inch or so wide, on the surface of the journal. These rings were so hot, you could not hold the finger tips upon them for more than a second. We could not stop nor could we remove the bearing, which by the way was babbitted, to scrape it to a good bearing again, so it was suggested to try grinding it in with Sapolio.

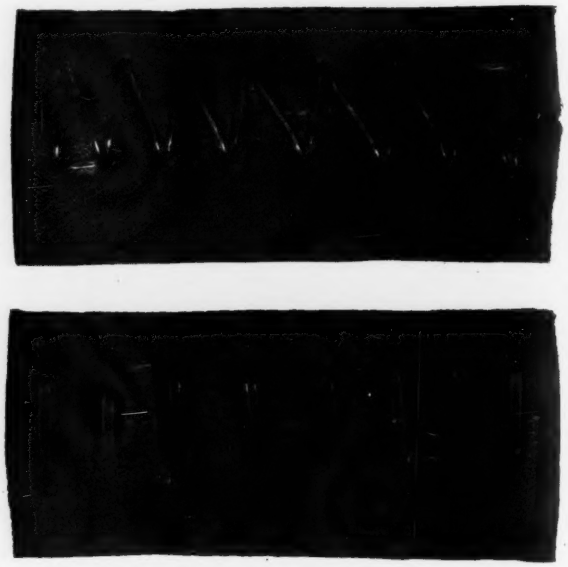


FIG. 2. SAMPLE OF WIRE LACING WHICH HAS BEEN IN USE 12 MONTHS

A hose was rigged upon the bearing and water allowed to trickle slowly down on the hot blue rings on the shaft journal, and a cake of Sapolio applied. After a while the rings began to disappear, and upon stopping the water and applying oil there was no tendency for the bearing and journal to heat up again.

We ran the water again for a few minutes to wash out any particles of Sapolio or metal that might be in the bearing and finally applied the oil in the usual way, which was by feeding it through 3 sight-feed cups, one in the center and one at each end. We never again had any trouble with the bearing. For such purpose the Sapolio is not only quick in its action, but it is easily washed out after you are through, as it has no tendency to bed itself into the soft metal and stay there to cause future trouble, as would be the case if emery or ground glass were to be used instead.

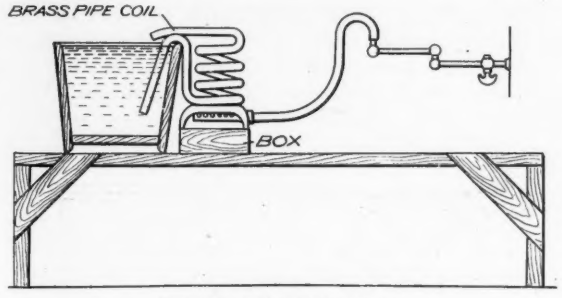
Concerning the inquiry on belting by H. C. G., page 708, I would say that when all things are considered a rubber belt would be better than a can-

was belt for him. The allowable tension on a rubber belt is as follows: From 12 to 15 lb. per ply, per inch in width, the larger factor is used with the thicker belts. In regard to the manner of lacing a belt, some of the most experienced men in that line prefer wire lacing to the more commonly used leather lacing. Copper wire may be used, and laced in the same way that a leather lace is, and the copper will last longer than the leather will, and it, in my opinion, makes a better all around job.

Without going into refinements, diagrams No. 2 presented by H. Johnston, page 705, give an average area of 5.6 sq. in., and, an average height of 1.51 in. This in turn gives a m.e.p. of 90.6 lb. per sq. in. for the cylinder at the time the card was taken, the horsepower of that cylinder was 679, and assuming that the low pressure cylinder was developing a like power, gives 1358 as the total power of the engine as a whole. The initial pressure is but 125 lb. showing quite a drop from 145 lb., if that is the usual pressure carried. H. Johnston better take diagrams from both cylinders simultaneously and then the power can be accurately determined. His boiler and engine are not quite able to do all that is required of them, under present conditions. Charles J. Mason.

A PUZZLER

LAST spring, while clearing up a lot of rubbage and junk, I came across a small coil of brass pipe, ⅛ in. diameter, having about 5 turns 2 in. in diameter, one end was about a foot long, which I bent as shown in the sketch. I decided to try a little experiment with the coil, I placed the bent end into a pail of water so that the short end just hung over the edge of the pail, then I put a small gas hot plate under the coil,



SIPHON HEATING COIL

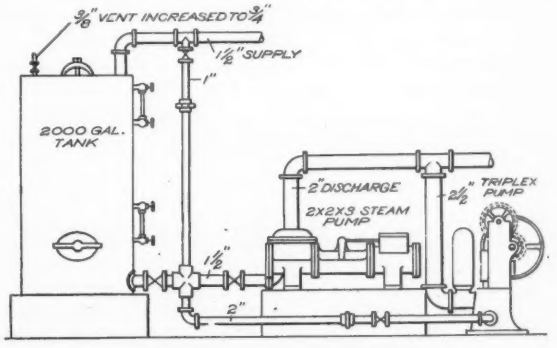
and connected the hose to a fixture. An old tin can which happened to be near by was put over the top of coil to help keep the heat in, then I lit the gas. About this time the telephone bell rang and I left the whole thing to itself. When I returned there was hot water coming from the small end of coil, and the water in the bucket was quite warm, the coil acted as a siphon and heater at the same time.

I turned off the gas, as I had other things to attend to, thinking I would come back soon. Several days went by before I had time again to play with my toy. I lit the gas again, but nothing happened in the fountain line. I tried to get results by filling the coil with water first, but failed again. I raised, then lowered it, tried different temperatures with the hot plate with no results. I have tried everything that I could think of to get that thing going again; several friends tried their hand with it but no successful results were obtained.

What I want to know is what started the water the first time? Have any of the readers of Practical Engineer ever had a like experience, and then failed? I haven't given it up yet. R. T.

PUMPING FROM SUPPLY TANK

HAVE had a peculiar experience with a Gould triplex geared pump connected direct to the bottom of a tank, which was filled with water at night, by city pressure, the inlet cock would be shut off in the



PUMP AND TANK CONNECTIONS

morning, and when the pressure was insufficient during the day I would draw from the tank. Now if the air vent on top was not opened the pump would run for a short time, according to the height of water in tank, and then the belt would run off, and the pump would turn backward a turn or so until the valves were tight against the seats, causing them to stick, and give trouble in starting up again. This was due to the vacuum in the tank, as soon as the air vent was opened, water would be forced from the packing glands on the pump, which was probably caused by the inrush of air.

One day, having some spare time, I connected a steam pump, as shown in the sketch, thinking that the belted pump was at fault. Starting both pumps together with the vent closed, the belted pump being largest would bring the steam pump to a stop with a bang, but if the vent was opened and both pumps going the belted pump would hold the steam pump in such a way that the valves would be partly open and water pass through, giving the belted pump the same water over again. This puzzled me at first, as I could not see into it, but by trying both pumps separately, I found the cause. A larger vent on the tank cured the whole trouble.

By closing the vent on top and opening the supply cock I could draw water from the street main, then when the pump would stop water would still run into the tank until the vacuum was gone. During the day the city pressure would not force the water into the tank, but by using the pump at certain hours, as described, I could keep a supply in the tank.

R. Thiede.

PUMP SUCTION

THE reason for a pump taking short strokes when starting, as stated by H. C. G., depends on location. He did not state whether the pump was below the level of the supply water, but I presume it is above and that the water flowed from the pump back to the well when the pump was stopped, because there

was no check or foot valve on the suction pipe. This would cause the pump to take short strokes until the air was driven out of the water cylinder.

The remedy for this would be to place a foot valve at the bottom of the suction pipe and if this did not entirely overcome the trouble it might be necessary to tap a priming pipe into the suction pipe near the pump. Taking water from a tank or city supply main to fill the suction pipe when starting. This would then fill the water cylinders and force the air out through the air valve on the discharge chamber if this valve were opened when starting up. This primer connection to the suction line also works to good advantage in case the open heater is pumped dry, allowing steam to enter the suction chamber and cylinder of the pump. A jet of cold water turned into the suction chamber would immediately condense the steam so that water would flow from the heater to the pump.

R. A. Cultra.

OILING HIGH SPEED ENGINE BEARINGS

I ONCE had charge of a 12 by 12 high speed engine, with which we had a great deal of trouble. The main bearings would get hot even when they were fairly loose, and had a liberal supply of oil running over them. The engine ran at 285 r. p. m., and was oiled by a small oil cup on each bearing.

I determined that more oil would have to be used on the bearings, and set about to rig up an automatic

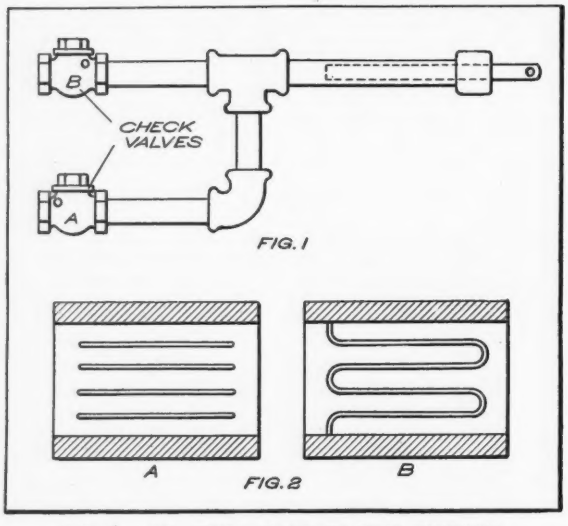


FIG. 1. OIL PUMP MADE OF PIPE FITTINGS

FIG. 2. ORIGINAL AND IMPROVED METHOD OF GROOVING BEARINGS

oiling system. A piece of 4-in. pipe, having a cap on one end, was put in a lathe and cut off to the length of about 12 in. This was used as an oil tank, being placed on an iron leg about 2 ft. above the engine.

From this tank I ran ¼-in. pipe to all the bearings. The oil, after running over the bearings, dripped down into the bed of the engine, and ran out, through a drain into a bucket.

I next made a little plunger pump of pipe fittings, as shown in Fig. 1. This pump was secured to the side of the engine by braces and the plunger attached to the valve stem of the engine. The suction side A was connected to the drain in the engine bed, and the delivery B to the oil tank. As fast as the oil ran over the bearings, and down into the base of the engine, it was pumped back into the tank. In this way a stream of oil was kept running over the bearings.

The bearings, however, would not take the oil very fast, so I thought perhaps the oil grooves might be stopped up. On taking the boxes off to examine them, I found that the grooves were put in, as shown at A, Fig. 2. I connected these grooves, as shown at B, and had no further trouble.

After making this arrangement, the boxes could be run quite snug, without any heating. The oil, of course, had to be taken out and filtered occasionally.

R. L. Rayburn.

PACKING AMMONIA VALVE STEM

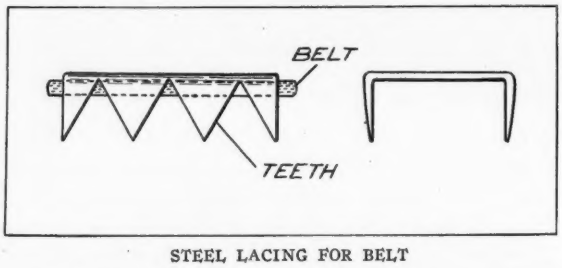
IN the plant where I am employed we had considerable trouble with the gas valve stem between the cooler and absorber of our refrigerating machine leaking ammonia gas. We first repacked the stem and found no relief. We then ordered a new stem and gland for the valve and after putting them in and repacking we again found the valve stem leaking as badly as ever. We thereupon tried fibrous metallic packing, but found that to be no remedy.

We noticed that the trouble was in the packing freezing and we then hit upon the idea of soaking ordinary round ¼-in. stem packing in brine for a few days and allowing it to become thoroughly saturated with it and packing the stem with that. The stem has been packed with it now for a month and has not leaked in the least. Previous to trying this, the valve always opened and closed hard, on account of the gland being screwed up hard to prevent leakage. Now the valve works very freely without leaking.

Frederick M. Perras.

SOME BELT DIFFICULTIES OVERCOME

IN the November number H. C. G. inquires about belting. As I have had considerable experience with belts, both as to dust and dampness, I would like to



STEEL LACING FOR BELT

state that when I had charge of a big rock crusher turning out about 600 yd. of crushed rock in 9 hr. we had a conveyor belt 14 in. wide by 250 ft. long, but we always had trouble with it. I got the owner to get a rubber belt and it was in steady use for over 2 yr. while I had charge and for quite a while after that when I was still in that neighborhood. When crushing the dust was so thick I could not see 10 ft. away from where I was standing.

For driving belts we had trouble with slipping and peeling, because the grit of the crushed rock would stick to the damp places and the wooden pulleys. I got Gandy belting, a combination canvas belting, red in color, and quite thick. It stood the test of both dampness and dust for driving belts.

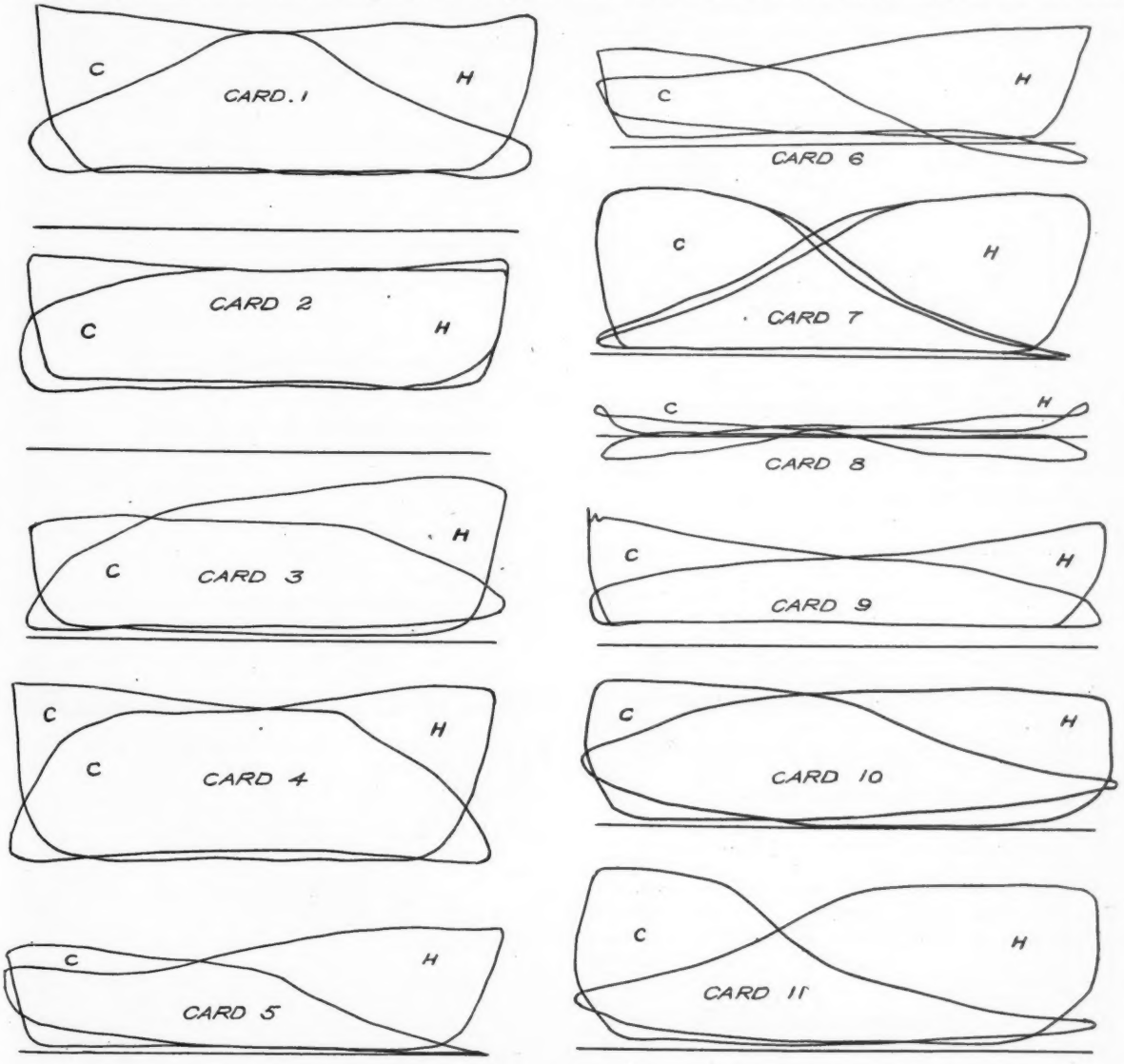
In reference to lacing, there is a steel lacing on the market that I have found to outlast a half dozen

leather lacing. It is flat in the middle, the sides are turned down and are cut out like saw teeth, as shown in the sketch. The teeth are driven through the belt and then are clinched on the inside.

Honolulu. W. Ellerbrock.

SUCH CARDS!

HEREWITH I am sending some cards from different styles of engines which are worthy of study and comment by readers of Practical Engineer. It is quite evident that there are some horrible examples among them, and the discussion of what bad qualities of setting are indicated by the cards will bring out a lot of things that ought not to be done. What have the readers to say about them? W. D.



CARDS 1 TO 8 INCLUSIVE ARE FROM A COMPOUND CORLISS ENGINE; CARD 9, ATLES SLIDE VALVE; CARDS 10 AND 11, FROM SIMPLE CORLISS ENGINE

BETTER THAN SIGNALS

I NOTICE on page 783 of the December number that some one is looking for "A Signal System" so constructed that the man on duty could not tamper with it. It seems that they have trouble keeping the men awake during their run.

The best system that any man can invent with fairness to fellowmen and the public at large is to put on a third man and have 8-hr. shifts. I have had considerable experience working nights where each man was on duty from 6 to 6 and know how hard it is to keep awake during the early morning hours.

I hope the time will soon come when all power stations will awaken to the fact that men are not mere machines, that nature's laws must be obeyed, or man's efficiency is greatly impaired. M. V. Miller.

TO KEEP SMALL particles of dirt and foreign matter from stopping up the spout of an oil can a correspondent of Popular Mechanics uses a sieve shaped like a thimble in the lower end of the spout. Any fine gage wire can be used for this purpose. This catches all the dirt but does not stop the flow of oil.

PIPING AND MACHINE POINTERS

By A. Wiedenlauer

HOW many times you have found the only close nipple in the engine room needs attention! Well, so have I, but I have a set of nipple wrenches now and I get them out occasionally. The accompanying sketch will show the general construction of the wrenches I made. Take a tee of proper size to fit the close nipple, put in short lengths of pipe as shown in the sketch for a handle, cut a groove in the

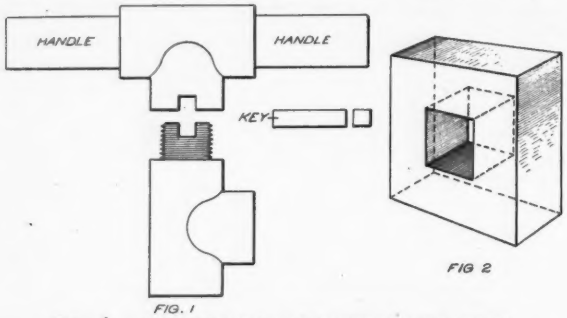


FIG. 1. HOME-MADE CLOSE NIPPLE WRENCH
FIG. 2. TAP WRENCH MADE FROM DIE

tee and nipple, either with a file or hack saw, and make a key to fit in this slot. To operate the wrench, screw the tee on the nipple and insert the key. The rest is simple and you will no doubt know enough to hold the key in place, I didn't the first time I used the wrench and had considerable difficulty with it.

Tap Wrench

TO make tap wrenches drill and file out worn dies. I usually use ⅛, ¼, ½ and ¾-in. dies, making 1, 1¼, 1½ and 2-in. tap wrenches, which can be used in

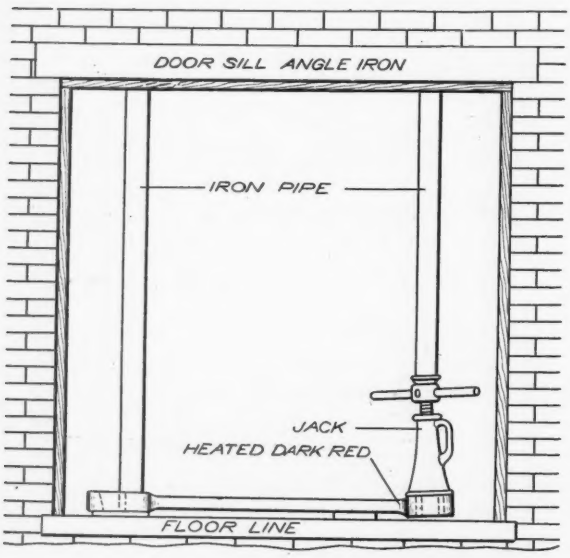


FIG. 3. METHOD OF STRAIGHTENING CONNECTING ROD

a pipe die stock. This is an exceedingly easy way to get wrenches which are strong and convenient for use at any time.

Straightening Connecting Rod

THE engineer forgot to remove a chunk of lead before starting his 100-hp. Buckeye engine and after starting he did not need to think, it was up to the machinists on the 7th floor, they thought, and the way the trouble was remedied is shown in the accompanying illustrations. From the time of taking out to putting back the rod, 2 hr. elapsed, for thoughts and all.

The connecting rod was put into a forge with a handful of fire (that's all the forge would hold), heated to a dark red and placed in the doorway of the engine room. The door being through heavy brick walls with channel irons across the top and bottom, the connecting rod was placed as shown in Fig. 3,

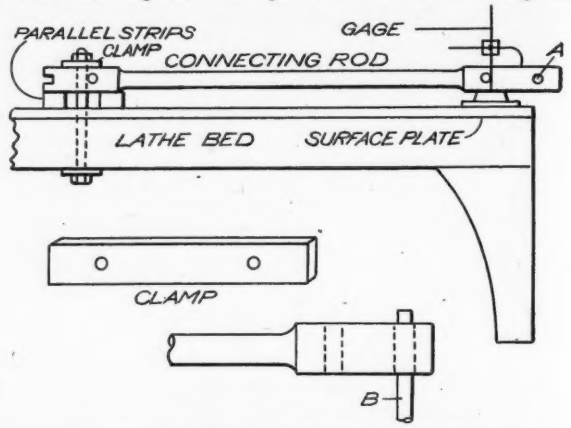


FIG. 4. TAKING THE TWIST OUT OF ROD

with an iron pipe brace at one end and a jackscrew over the other, an iron block being placed to one side of the bend.

The lathe bed was used to take out the twist of the bar, the head end being held fast with bolts, a bar, B, was placed in the hole at the butt A, and after a pull or two the rod was straight. A surface gage was used to indicate when the twist had all been taken out.

FEEDING COMPOUND TO BOILERS

NEARLY all engineers are troubled more or less by the deposit of scale in their boilers. In some cases this is in the form of mud settling to the bottom where it remains until washed out with the hose. In other cases the scale forms a hard coating on all parts of the surface exposed to the water.

Water may be clean to all appearances, yet contain a good deal of sediment, and as the boiler evaporates a large amount in a short time a few grains of sediment carried in with the feed water at intervals will in a short time accumulate quite a deposit. Frequent use of the blowoff will remove the soft sediment but will not take care of the hard scale, and oftentimes some of the soft sediment will not be taken care of by the blowoff. This is not an argument against the use of the blowoff, which should be used frequently, and at times when the circulation is quietest, such as in the morning or during the noon hour when the deposit is likely to be settled to the bottom of the boiler.

In order to keep out the hard scale, some form of boiler solvent or compound must be used regularly, the kind to use being determined by chemical analysis of the water to be treated. For the best results, this compound should be introduced regularly and systematically instead of at the infrequent intervals of boiler cleaning. If introduced only when the boiler is shut down, not only are the periods between treat-

ments too long, but a large part of the compound is blown out of the boiler in the course of ordinary running, long before a new charge is introduced.

To avoid this condition the best method is to use some form of continuous feeding apparatus so that the compound can be put in at any time and in any quantity. Small quantities injected daily accomplish the best results and avoid any possible cause of foaming.

Usually some means of introducing the compound into the feed water as it goes to the boiler feed pump is adopted. Figure 1 shows a method frequently seen,

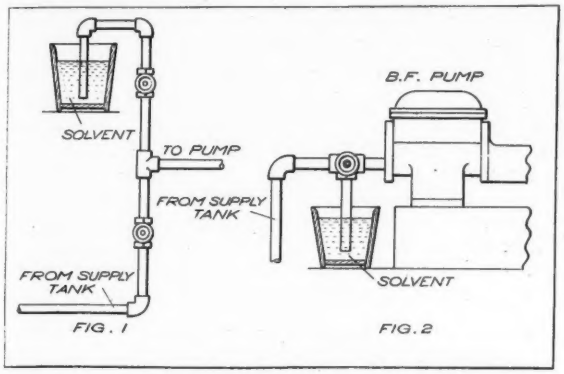


FIG. 1. COMMON METHOD OF FEEDING COMPOUND
FIG. 2. ARRANGEMENT FOR FEEDING COMPOUND CONTINUOUSLY

in which a tee is put on in place of an ell on the suction pipe to the pump, carrying the pipe up above the pump and inserting a valve then dipping into a pail placed as shown. When using this apparatus, it is necessary to put in the charge intermittently rather than continuously, that is, a certain amount of solvent must be pumped in while no water is being drawn and then the water allowed to feed with the connection to the pail shut off. This necessitates a valve in the feed pipe below the tee.

This device is, however, unsightly, and the arrangement shown in Fig. 2 is to be preferred, both for appearance and because it makes it possible to feed the boiler compound continuously. In Fig. 2 a branch is carried to one side of the pump and then down toward the floor, using an angle valve in place of the ell. The compound can be dissolved in a pail on the floor under the angle valve, then by opening the angle valve slightly a small amount of the compound may be sucked in with the feed water continuously, thus mixing each pump full of water with its proper proportion of compound.

One arrangement which I have seen work and which was very satisfactory consisted of a sink arranged so that the outlet could be stopped up and the compound mixed in the sink and a suction pipe from the injector extending into the sink so that the injector could feed the compound to the boiler. In this plant there was no pump and it was, therefore, necessary to introduce the solvent intermittently instead of continuously. The whole rig was constructed of brass pipe in order to avoid any possibility of corrosion or stopping up.

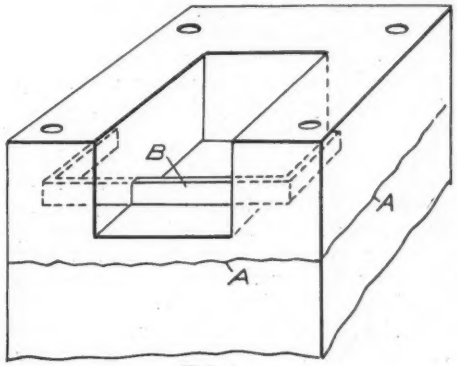
FRIENDS OF W. E. Sanders will be pleased to learn that he has accepted a position as sales manager for the Thermoid Rubber Co., and will in future be located at Trenton, N. J., in charge of the production and sale of the mechanical rubber goods of the Thermoid Rubber Co.

ENGINE FOUNDATION REPAIR

BY T. JONES

BECOMING crystalized, the piston rod of a large engine in a power plant, broke off square at the end, or base, of the thread, blowing it through the back end of the cylinder. The piston head was broken, also the back cylinder head, and 12 1⅜-in. studs broken off. The foundation under the cylinder had long been loose, and no matter how much the foundation bolt nuts were tightened, the engine would move. It was also out of line, so it was decided to repair the foundation and reline the engine.

About 3 ft. of the old foundation underneath the cylinder (this having been removed) was dug out, the rest being solid was left standing, and, after the surface was well chipped, and wetted, concrete was poured in. Figure 1 is a view of the foundation; above the line A is the new concrete. An opening was left for



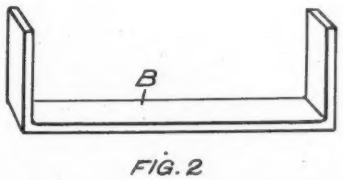


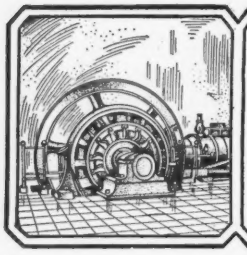
FIG. 1. REPAIRED ENGINE FOUNDATION
FIG. 2. TIE FOR ENGINE FOUNDATION

the exhaust pipe, and as it was feared the foundation would be weak, a tie rod of iron about 2 by 6 in. was bent in the shape B, shown in Fig. 2, and placed as shown.

The cylinder was then replaced and the engine lined up. For grouting, sulphur was used; the lump brimstone being at the time unobtainable, powdered sulphur was used. It was melted very slowly in a large iron pot, over a slow wood fire, great care being taken to prevent it from catching fire. A cover was fitted over the pot, which lessened the danger, and it gave off almost no fumes. Large tin buckets, provided with fixed wooden handles, were used in pouring. About 300 lb. were used for the job. All oil should be cleaned from the foundation or the sulphur will not harden properly.

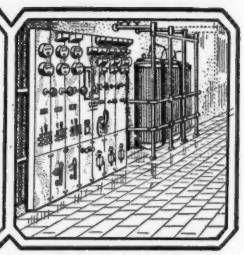
After the engine was running, a coin could be stood on edge on the cylinder and remain there while the engine was pulling a street-car load.

STRAINED BELTS make strained boilers.



Electrical Machinery

For Generating, Transmitting and Using Current



THREE-WIRE DISTRIBUTION

THIS system of electrical distribution was devised by Edison in 1882, and first put into practical use by the Edison Electrical Illuminating Co. of Boston in February, 1886, from which time its use has been general in lighting plants using direct current, and in many power plants.

From well-known laws governing electrical phenomena it is easily shown that the weight of copper required to carry a given power at a given per cent loss varies inversely as the square of the electromotive force.

In other words, if the voltage is multiplied by 2, the weight of copper with the same line loss will be the first weight divided by the square of 2, or 4. In the same manner if the voltage is multiplied by 3, the copper weight is divided by the square of 3, or 9. From this may be seen the immense advantage of using high voltages where practicable.

A difficulty, however, at once presents itself from the fact that high voltages are dangerous, increasing the chances of injury to those coming in contact with live wires, besides increasing the fire risk where the wires are brought into wooden buildings. As a compromise between the 2 evils of a heavy outlay for copper wire on one hand and of danger to life and property on the other, the 3-wire system was evolved.

In a few words the system consists simply in doubling the allowable voltage and placing the lamps or motors made for the allowable voltage in series of 2. The conditions are that the generating plant must produce 2 voltages, one voltage being one-half

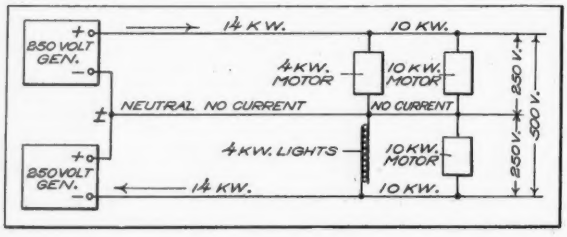


FIG. 1. IDEAL 3-WIRE DISTRIBUTION

of the other and that a neutral or third wire be carried back to the generating station and connected at a point in the generating circuit giving one-half the maximum voltage.

The purposes of the neutral wire are 2-fold, its first office being to convey current to the generator having the greatest load in an unbalanced system (see Figs. 3 and 4) and its second service is in carrying current from the terminals of the lights or motors on the positive side to those on the negative side, either in a balanced or unbalanced load.

Thus the neutral wire while carrying no current back to the generators, may at some other points be carrying heavy currents and in opposite directions on different sections of the circuit as shown in Fig. 2.

In practice the conditions will rarely allow connections to be made as in Fig. 1, in which the neutral wire carries no current at any point while the load is balanced, or off.

As neither the positive nor negative pole of the 3-wire circuit is grounded, it is evident that the differ-

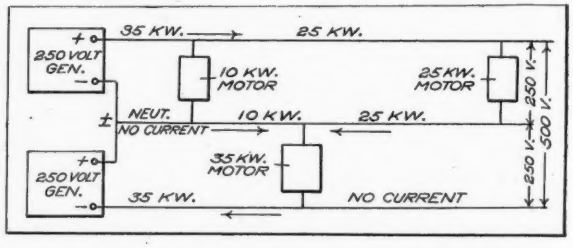


FIG. 2. COMMON CURRENT DISTRIBUTION IN 3-WIRE SYSTEM

ence in potential or voltage between any wire and the ground cannot exceed one-half the maximum voltage.

This is an important condition in mine work as it allows the use of 500-volt equipment with only 250 volts between the ground and any part of the circuit.

Where the neutral wire is placed almost entirely upon pole lines, as is customary in lighting circuits, it

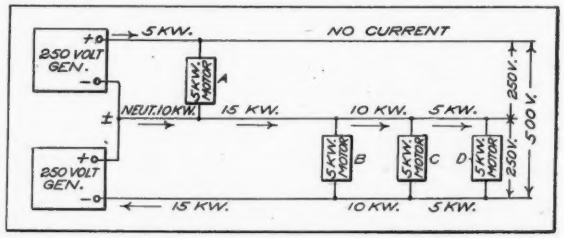


FIG. 3. UNBALANCED DISTRIBUTION ON 3-WIRE CIRCUIT

is customary to insulate it and to have it of the same size as the positive and negative wires, in which case the amount of copper required, as compared with a 2-wire system of the same capacity, will be 3 to 8.

In mine work the rails are generally utilized as the return branch of the circuit and where the 3-wire system is installed the rails form the neutral branch of the circuit. The fact that the rails are grounded while conveying current from one part of the circuit to another, as in Fig. 2, does not matter.

Referring to Fig. 3 it will be seen that the neutral wire between motors A and B is carrying the full current made by the generator. In practice the load is so distributed that this condition rarely occurs.

The motors may be so connected that the 2 sides will be balanced where the motor loads are proportionally the same, but in practice it is manifestly impossible to maintain this condition, and the excess load generally fluctuates to a certain degree from one side to the other.

In connection with the 2-generator system, apparatus has been devised to shift automatically part of the load from the heavily loaded side to the idle side, but it has never come into general use owing to the

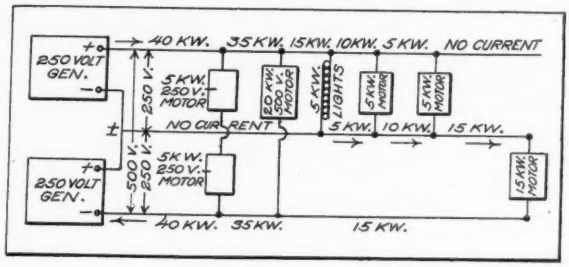


FIG. 4. BALANCED LOAD ON 3-WIRE CIRCUIT

complicated nature of the mechanism and its liability to get out of order. The latest practice consists in the use of apparatus constructed to meet the conditions.

Three-wire generators have been designed and placed upon the market by several manufacturing

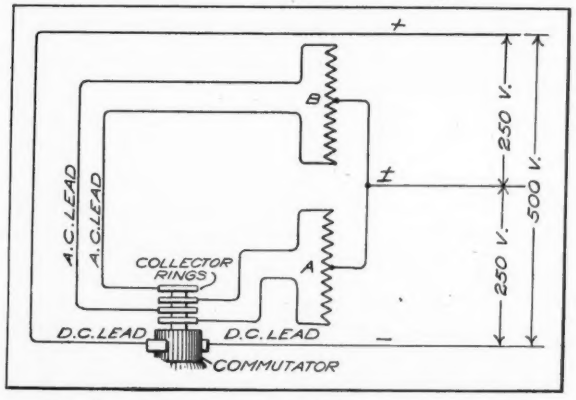


FIG. 5. METHOD OF CONNECTING BALANCE COILS

companies and they have been in successful operation for a number of years. These 3-wire or double voltage generators differ from standard single voltage direct current generators only in that additional leads from the armature winding are connected to collector rings mounted on the armature shaft. The arrangement is exactly similar to that employed for the alternating current side of the armatures of rotary converters.

This connection may be either single, 2 or 3-phase, but the 2-phase is generally used, as experience has shown it to give the best regulation.

Across the 2-phase collector (see Fig. 5) a pair of balance coils A B are connected. These balance coils differ from transformers in that they have but a single winding upon a laminated core. The mid points of the balance coils are inter-connected as shown in diagram and from this connection is led the neutral wire.

The voltage between the d. c. terminals of the 3-wire generator is 500 volts where 250 volts is required between the neutral and the other 2 wires.

Three-wire generators may be compound wound, and may be operated in multiple in the same manner that direct-current generators are operated.

APPLICATION OF FAN MOTORS FOR WINTER USE

IT is the popular opinion that the range of usefulness of the electric fan motor is limited to the summer months and that its sole utility lies in its application as a means of reducing the temperature of a room or an office. This is not true, however, and slowly but surely the public is beginning to understand that the usefulness of the fan motor is by no means confined to the hot days of summer, and that paradoxical as it may seem the electric fan blows hot and cold; and incidentally while it is blowing hot it cuts the fuel bill.

Following are a few of the more important applications of the fan motor to winter use:

The efficiency of the hot air heating system may be greatly increased by placing a fan motor in the cold air box to force the air through the registers to all parts of the house. On particularly cold days when the wind is so strong that it forces the air through the furnace into the rooms without having become heated, a fan motor placed in the cold air box, after having closed the slide which permits air to come in from the outside and opening the slide which lets the air in from the cellar, will cause an appreciable rise in the temperature of the room, without making any increase in fuel consumption.

As is very often the case, the house contains a room or rooms which under certain conditions are difficult to heat. This difference can be overcome by placing a fan motor in front of the hot air register or over it in case the register is located in the floor. This plan will prove more efficient if the register and fan motor are covered by a box or hood of some kind which will cause the fan motor to draw air from the pipe only, and not from the room.

In a house heated by hot water or steam, increased radiation of heat and consequently a warmer room may be obtained by placing a fan at the end or back of the radiator.

Another manner in which the fan motor may be used to advantage in winter is to prevent the accumulation of frost on show windows of stores. The air from the fan motor directed against the glass of the window will keep it practically free from frost. This application of the motor is a boon to merchants who have, heretofore, during the cold weather, lost practically all the advantage which their window display accomplishes.

EXPERIMENTS WERE CONDUCTED recently with geared turbines on the British steamer Vespasian for the purpose of determining whether this means of propelling would be a saving as regards fuel, weight and space in comparison with the best types of reciprocating engines. The result of the first test, as attained on an ordinary sea voyage gave a decreased steam consumption of 15 per cent.

A FOOT-POUND saved at a bearing means ten saved in the coal pile.

PROBLEMS IN THE OPERATION OF TRANSFORMERS *

BY. F. C. GREEN

THE slightest puncture of a transformer means that it must be dismounted entirely before repairs can be made. The oil must be drawn out, the leads disconnected, and the structure moved to a location where there are facilities for hoisting. Moreover, there is interruption of service with consequent loss of revenue and impairment of prestige. At its best, transformer repairing in a station does not inspire a feeling of enthusiasm for the electrical arts. And yet the damaged coils with their slime are the starting point of progress along manufacturing lines, as well as of progress along those lines that lead to the consideration of electric stress, line oscillations, temperature gradient, and other similarly advanced features of the science.

Thus, the main problems in the operation of transformers are to select those best designed to meet the service requirements and to give them such care in their installation and such attention in service as will minimize liability of unnatural weakness or abnormal strains. Important problems arise in the adaptation of transformers to a variety of service.

Installing

THE high voltages used now make necessary a large amount of solid insulation between high-tension and low-tension coils and between coils and laminations. The present manufacturing practice calls for solid insulating materials that are fibrous. These cannot be so treated that they will not absorb at least a small amount of moisture from the air during shipment or storage. Occasionally, facilities for handling transformers at the station where they are to be installed, admit of shipping with the oil in them, but as a rule the transformers and oil must be shipped separately. Hence the necessity for drying arises.

The full effect of the process used should extend to the fibrous insulating material as well as to the coils. In fact, a coil has to withstand normally a voltage not exceeding 6000 or 7000 volts and usually the voltage is much lower than this, while the voltage between windings may reach a normal value of 100,000 volts in modern transmission systems. Furthermore, coils are more easily dried than the insulation between windings. The usual short-circuit run heats the coils but the effect does not extend through the heavy insulating shields, because the heat is carried up by the air circulating through the spaces between the coils and shields, and is given up to the cover and tank.

The circulation of large quantities of heated air is an easy and effective process of drying. Where the tank is suitably constructed, the vacuum process of treating the transformers filled with oil, may be used. In this case the heat must be so applied as to maintain a uniform temperature of oil throughout the tank, and the degree of temperature and of vacuum must be so related as to cause the moisture to vaporize. Unevenness of temperature makes ineffective the vacuum process of drying without oil in the tank.

Oil may be dried by blowing heated air through it or by holding it at a temperature that will vaporize moisture, either at atmospheric or a lower pressure, such as is obtained in the vacuum process. The adaptation of the filter press with blotting paper to the treatment of oil, has proved to be most satisfactory. There is no danger of injury from excessive temperature, and both the moisture and sediment are removed. In case it should be found desirable, oil may be treated by means of the filter press without taking transformers out of service.

Causes of Failures

IF a high-voltage transformer is built with a safety factor of 10 instead of the usual factor of 2, it avails nothing in case of neglect to properly install it, assuming it to have become moist in shipment. It is equally true that this same transformer, being properly installed, is about as likely to break down as the one with the safety factor of 2. This brings up a consideration of the parts of the transformer most exposed to effects of conditions that practice has shown to be dangerous. Abnormal voltage conditions are responsible for almost all transformer failures. Examination of the damaged portions has shown that it is not the total abnormal voltage that is dangerous, but that the disturbance of the voltage equilibrium within the windings is responsible for a large majority of the operating troubles attributed to transformers. Thus, the percentage of puncture between high-tension and low-tension windings, or between the windings and laminations, is negligible as compared with the percentage of punctures between turns, or between portions of the same winding.

The standard practice for the potential test of high-voltage transformers is to apply twice the rated high-tension voltage between the high-tension winding and the low-tension connected to the iron. The induced voltage test is the application of twice the rated voltage to one of the windings. The purpose of the induced voltage test is to determine whether the various portions of a given winding are properly insulated from one another. This test of course subjects adjacent turns to twice the normal voltage between turns, but, as will be seen, this does not mean much except in cases of mechanical defects which are rare.

While modern lightning arresters successfully limit to a safe value the voltage between phases, and between the line and the ground, they are not adapted to the protection of the transformer against the concentration of a dangerous voltage upon a small percentage of the total winding.

The portions of the winding most liable to excessive voltages of this kind are toward the line ends; but this is not always the case, the relative location of the danger portion depending upon the nature of the disturbance of the voltage equilibrium. The percentage, however, of transformer failures is small; but there is reason to believe that it can be reduced to an inappreciable value by means of increasing the effective insulation between parts of the winding most liable to damage, and by means of reducing line disturbances to a practicable minimum. Also, the transformer is less liable to the effects of line disturbances where its capacity in microfarads is small.

Another case of destruction of transformers is their connection to bus bars of generators having a total capacity many times greater than that of the transformer. Before this kind of trouble appeared, with

*Abstract of paper to be presented at the Pittsfield-Schenectady mid-year convention of the A. I. E. E., February, 1911.

the concentration of large amounts of power, it was desired and specified that the transformer regulation should be a minimum. To meet this specification a low reactance was necessary. Thus in many instances the impedance voltage was limited to from 2 to 4 per cent. If a transformer is assumed to have 3 per cent impedance voltage, and to be backed with sufficient generator capacity to maintain normal voltage, a current about 30 times normal will flow when a feeder leading from the transformer becomes short circuited. The flow of such a current in a medium or a large size transformer produces electromagnetic stresses of many tons. The forces exerted are in such relation to one another as not only to flare the ends of coils over the supports for holding them together; but also to twist and distort the individual coils.

This sort of trouble has been cured by inserting separate reactance in circuit with transformers having low inherent reactance, by designing for higher inherent reactance, and by increasing the surface of coil supporting strips. Experience has shown that a quick-opening switch is not effective in protecting a transformer against the distorting forces of heavy current rushes in cases of short circuited lines.

Care in Operating

WHERE artificial cooling is used, the circulation of the cooling medium should not be neglected; the transformer cannot run continuously even under no load with the circulation shut off. The cooling coil of a water-cooled transformer is liable to become stopped up with weeds and grass, which restrict the flow of water, or a coating of dirt and mud may form inside the coils, decreasing the effectiveness of the cooling. Occasionally chemical action takes place between the water and the metal of the coil resulting in a formation that lessens the effective cross section. Systematic observation of the flow and temperature of the water and of the temperature of the oil in the transformer, will give an indication of approaching danger from any of these sources.

Another feature of cooling that sometimes leads to a critical condition is the forcing of the circulation on occasions of heavy overload. If a very large amount of cold water is forced through the coil, and the coil is in good condition as regards its internal surface, then the temperature of the oil is maintained at a value, under a very heavy overload, that gives no indication of the temperature of the transformer windings. It has been demonstrated in service that it is possible to seriously overheat the windings without unduly raising the temperature of the oil.

The oil transformer that relies upon tank surface or its equivalent, for cooling, is generally considered as requiring no thought in its housing, or attention in service. It is supposed to be self-cooling, regardless of surroundings that do not admit of the free escape of the heat.

If six 500 kilovolt-ampere transformers are found operating in a room 15 ft. by 30 ft. by 15 ft. it is generally expected that they will operate satisfactorily regardless of whether or not there are openings in the room for the circulation of air. Now, assuming the losses to be 2 per cent, there are 60 kw. of energy to be radiated. This is equivalent to 80 hp. Imagine an 80-hp. boiler making steam at its normal rate, for a room of the dimensions given above, on a hot summer day; this will give an idea of the necessity of proper ventilation of the room and of the spacing of the transformers. To limit the temperature rise of the air in the room to 5 deg. C., would require the circulation of approximately 21,000 cu. ft. of air per minute. The air in the room would have to be entirely renewed 3 times per minute.

It should not be assumed that the manufacturer is free of responsibility in questions affecting the operation of transformers. It is not only necessary to have reliability and efficiency, but the transformer case should be built so as to facilitate crude handling as well as crane handling; and connectors for changing ratio should be easy of access and manipulation.

Connections That Develop Trouble

FIGURE 1 shows a combination of transformers and generator commonly used in large cities. In some instances the triple frequency voltage established by the generator has been of sufficient value to cause

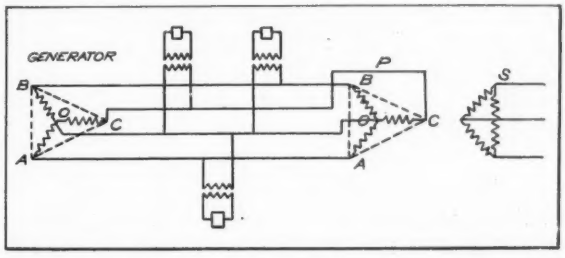


FIG. 1. TRANSFORMER AND GENERATOR COMBINATION THAT DEVELOPS TROUBLE

heavy triple-frequency current to circulate in the delta of transformers for 3-phase service. It is understood that the triple-frequency voltage does not appear between lines, but only between lines and the neutral point. (See paper by J. J. Frank, Proceedings A. I. E. E., March, 1910.) Therefore, the fourth wire connected to the neutral point for the distributing system, admits the circulation of the objectionable current in the windings of the transformers connected in delta

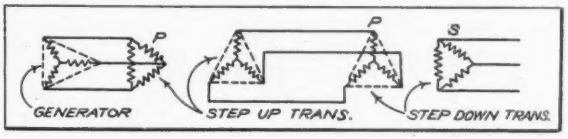


FIG. 2. TROUBLE-MAKING CONNECTION USED IN LONG DISTANCE TRANSMISSION

as shown in Fig. 1. This no-load current has been known to reach values ranging from 50 per cent to 90 per cent of the full-load current.

The objectionable current has been easily eliminated by simply disconnecting the fourth wire banks of transformers used for 3-phase service. If it is desired to ground the neutral of the distributing system the generator neutral may be grounded. This keeps down the static electricity usually noticed in stations where the neutral is not grounded. It is not necessary to ground the neutral of the bank of transformers for the motors.

Figure 2 shows a combination used for long distance transmission of power. Any triple-frequency component in the generator voltage simply results in shifting the neutral of the generator in case the neutral is not grounded and in rocking the 3-phase voltage impressed on the transformer in case the neutral is grounded. Its effect, except for this rocking back and forth of the voltage triangle, when the neutral of the generator is grounded, does not appear anywhere

in the line. The question arises as to why, if we find a considerable voltage between open corners of the step-down delta, a current would not flow in the delta when it is closed, corresponding to the voltage observed divided by the triple frequency impedance of the transformers? It was seen in Fig. 1 that under a similar relation of primary and secondary windings we observed nearly full-load current circulated. In Fig. 2 the triple-frequency voltage found between points of the open corner is due to the nature of the

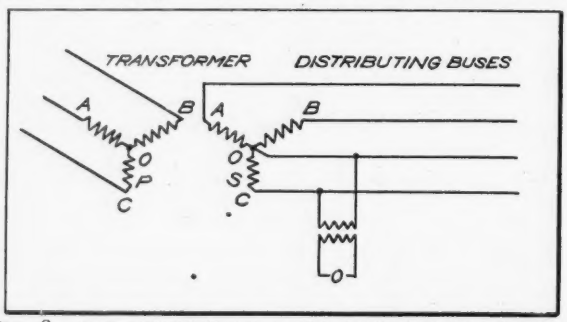


FIG. 3. BAD CONNECTIONS WITH SINGLE PHASE TRANSFORMERS

transformer, and therefore, only a very small magnetizing current is necessary to re-adjust the voltages. The current is inappreciable whether the neutral points are connected together or not.

Figure 3 shows a combination of 3 single-phase station transformers for distributing purposes. The conection is Y—Y, and while not a common one, is used in at least 2 large cities in the United States, with this difference, that in one, both the high tension and low tension neutrals are grounded, while in the other only the low tension neutral is used for a fourth wire service. In the instance where the high tension neutral was not used, considerable trouble was experienced in the unbalancing of the phase voltages of the distributing system. If the load is perfectly balanced and the transformers used in the stations have identically the same magnetizing current, then there would be no unbalancing of distributing voltage. Experience, however, has shown that it is practically impossible to obtain such perfect conditions and therefore this combination is bound to result in extreme unbalancing of voltages.

In order to understand why this combination is so easily unbalanced it will be assumed that current is being drawn between the fourth wire 0 and the point C, Fig. 3. This current represents unbalancing and is drawn from the winding O C of the secondary of a single-phase transformer in a 3-phase combination. But there cannot be current in the secondary without corresponding current in the primary. Thus, in addition to passing through O C in the primary, the current must also pass through either O A or O B or both. No current is passing through O A or O B of the secondary. Therefore, any current passing through O A or O B of the primary must be magnetizing current. Thus, with very small current delevered between O and C of the secondary, the voltage between O and C of both the primary and secondary becomes approximately zero and the point O extends to C.

The unbalancing of the voltages was eliminated by connecting a 3-phase transformer across the distributing lines in such a way as to admit the circulation of the balancing current.

THE CHICAGO ELECTRICAL SHOW OF 1911

IT has come and it has gone, leaving a memory of bright lights, wonderfully ingenious devices for making life less laborious, and more luxurious, and of ingenious development in all lines. Largely the exhibit was made up of conveniences for domestic, office, and factory use, the application to everyday wants being the great keynote of the exhibits. Fans to keep us cool and supply fresh air, cleaners to keep us dustless, appliances to rest the tired muscles, the swift, silent and sure electric auto, the electric washerwoman, the daylight quality tungsten electric lamp and the flaming arc, and motor applications for blowing, grinding, printing, pumping, mailing our letters, and even for writing them, showing how far we have progressed toward being a motor-driven people.

From the power plant point of view, the exhibit was interesting rather as showing in what way load may be increased, than as a study of apparatus used in the plant. Some few exhibits contained, however, apparatus which lies within the province of the engineer and these will be given special description.

Long awaited and many times postponed, the Edison storage battery has within the last year come forth as a commercial apparatus, particularly for automobile use, and is now put out under a 5-year guarantee for automobile and ignition purposes. The negative plate consists of flat perforated pockets filled with iron oxide and the positive or perforated cylindrical pockets filled with nickel oxide, these pockets being held in nickel-plated steel frames, and assembled in compact packages. The retaining cans are of sheet steel nickel plated, and the only care necessary aside from charging the battery, is filling it occasionally with distilled water. The larger size cells are made for 30, 45 and 60 amperes discharge at a 5-hour rate, and requires 7 hours for discharging fully. The voltage on each cell is 1.2 and the weight for a 30-ampere cell is 13 1-3 lb., and for a 60-ampere, 25⅛ lb. Larger capacity can of course be secured by putting cells in parallel.

THE WESTINGHOUSE SPACE contained exhibits by the Westinghouse Electric & Manufacturing Co., the Westinghouse Lamp Co., and the Cooper Hewitt Electric Co.

The feature of the Westinghouse Electric exhibit was a new adjustable speed alternating current mill type motor, which the company has just brought out. The motor, designated as "Type MW," is designed for severe, intermittent, varying speed, reversing duty, such as the operation of cranes, elevators, roller lift bridges, etc. The detail and supply apparatus exhibited comprised cooking and heating devices, meters, transformers, rectifiers, etc. Several new 1911 model fan motors were shown; these included 12 and 16-in. mechanically oscillated types for both wall and desk mounting, and a 12-in. exhaust type for ventilating purposes.

The Westinghouse Lamp Co. exhibited complete lines of 110-volt wire type tungsten lamps, ranging in size from 25 watts to 500 watts, and of 220-volt wire type lamps, ranging in size from 45 to 500 watts. Street series tungsten lamps were shown in different sizes, ranging from 50 to 250 watts.

The Cooper Hewitt Electric Co. displayed a direct current and an alternating current lamp. These were mounted in an attractive manner, which showed the operating mechanism. Literature was distributed showing several well known installations of Cooper Hewitt lamps in factories, warehouses and round houses.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS distributed copies of its magazine, "Ambition," together with other literature concerning the correspondence schools, particularly in regard to the courses in electricity. In the booth were 2 globes representing the earth, moved in a novel way to point out the advantages and scope of the I. C. S. courses.

IN THE BOOTH OF THE National Electric Lamp Ass'n were exhibited Mazda lamps for all purposes, comprising lamps for head lights, use on battery circuits, flash lights, surgical purposes, train lighting, and were made for voltages from 1½ volt up, and in candle powers from 2 to 40. The uses of these lamps for various purposes such as show cases, picture lighting, and so forth, were made a feature of the exhibit.

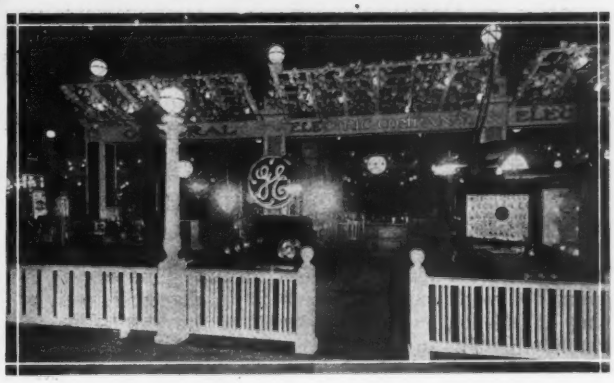
ALLIS-CHALMERS Co. exhibited a line of a. c. and d. c. motors and recently developed types of lighting transformers. The application of motors to centrifugal pumps was made a feature of the exhibit, also the portable air compressor plant for household and power plant use.

THE CUTLER-HAMMER MFG. Co. has for years made a specialty of rheostats and starters, but has more recently branched out into the allied fields where resistance wires are applicable. In its booth were exhibited household appliances such as water heaters, radiators, irons, chafing dishes, and so forth. One of the latest developments is a new type of quick break switch for lamp circuits and these in various sizes were on exhibit.

THE AMERICAN SCHOOL OF CORRESPONDENCE had on exhibit a complete library of books published by that school. A particular feature was made of the electrical courses and literature concerning other publications and courses was distributed.

IN THE BOOTH OF THE Ft. Wayne Electric Works was shown the application of Ft. Wayne motors and other apparatus to industrial uses, the principal ones being for rock drills, fans, and air compressors. Besides these there were shown the vertical shaft direct current motor, also the horizontal type corresponding to it, a small switchboard panel, alternating current regulator for arc lamps, portable wattmeters, parts of small motors, the Compensarc used in moving picture theatres, starting rheostats, instrument and lighting transformers.

GENERAL ELECTRIC Co. had a complete line of household and heating devices on exhibit and demonstrations of their uses were made by attendants in the booth. There was also a line of motors for household use exhibited in this booth. Besides these were shown exhaust fans, electric breast drills, compensators and rheostats, theatrical spot arc lamps, automobile lamps, a moving picture rectifier, motor driven air compressor for garage work, complete line of Mazda and arc lamps, meters, instruments and lighting transformers. One of the latest developments of the company is the C. V. C. direct current power motor, a number of which were on exhibit in this booth. Another appliance of considerable interest was the steam and air flow meter which has recently been perfected by the General Electric Co. This instrument records the number of pounds of steam, air, or other gas which is flowing through a pipe and compensates for variation in superheat and steam temperature automatically.



BOOTHS AT THE CHICAGO ELECTRICAL SHOW

MAKING ICE FROM RAW WATER

IN THE PLANT OF THE CITIZEN'S ICE CO., TOLEDO

DIFFICULTIES ENCOUNTERED in securing pure, clear ice without the use of distilled water has, in many cases, compelled the use of steam driven ammonia compressors where gas engines or electric motors would have been more economical for power alone, but, since the water had to be distilled for making the ice the steam engine was most economical. A recently discovered system of ice making, however, has made it possible to manufacture ice from ordinary city water and the use of electric motors and gas engines for operating the compressor in ice plants seems destined to become more common.

The new plant of the Citizen's Ice Company of Toledo, Ohio, is the second to employ the Bishop-Cell-specifications based on gas containing 900 B. t. u. pe cubic foot at 60 deg. F. and 30-in. barometer.

The engine is started with compressed air furnished by a compressor run from the line shaft, whicl is divided into several sections and run from the engine shaft by means of clutches and couplings. In starting up the plant originally the compressor was run by a motor belted to the line shaft the method being clearly shown in the illustration. This motor was made by the Wagner Electric Mfg. Co., and is for 3-phase, 60-cycle current, being known as type BP. It has a capacity of 25 hp., runs at 700 r. p. m., and is supplied with current at 220 volts which is furnished from an outside source.

The compressor for starting the engine is so attached to the line shaft by means of a belt that it may be put into operation by throwing in a clutch so that

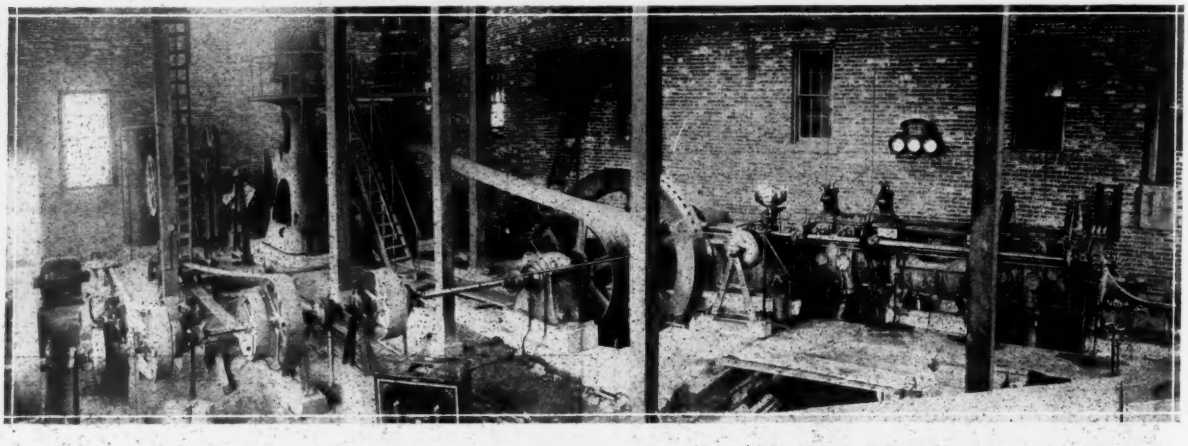


FIG. 1. PANORAMA OF ENGINE-ROOM IN CITIZENS ICE CO.'S PLANT

Block system, which has been perfected by the Great Lakes Engineering Works of Detroit. In Fig. 1 is shown a panorama of the compressor and engine room under construction. The main driving unit is an Allis-Chalmers gas engine of the double acting tandem type with 18-in. cylinders and 24-in. stroke. The engine is provided with one flywheel 9 ft. in diameter, weighing 15,000 lb., the total weight of the engine being 95,000 lb. The main belt wheel which drives the compressor from the shaft of the engine is 77 in. in diameter and has a width of 34 in. The horsepower developed by the engine is 375 when running at 200 r. p. m.

The gas is ignited by current from a generator run by belt from the governor shaft of the engine. This generator has a capacity of 0.3 kw. and delivers direct current at from 25 to 30 volts, running at a speed of 1050 r. p. m. This ignition system is supplemented with a storage battery of ample capacity to take care of the ignition should the generator at any time fail to operate.

The cylinders are water jacketed, water being supplied from the city mains for cooling. Lubrication of the engine is secured by means of 2 Richardson Sight Feed Oil Pumps, which deliver the oil to the various wearing parts of the engine.

Natural gas is used in the engine, being first passed through a gasometer, and the engine was built upon

when the air has reached the required pressure in the receiver the compressor may be thrown out of service without interfering with the operation of other apparatus in the plant. This compressor is of the 2-stage type with cylinders 6½ and 3 by 5 in., and was manufactured by the Union Steam Pump Co.

Another section of the line shaft operates the compressor which furnishes air for the 2 Curtis air hoists used in the freezing room and the deep well pump is also belted to this shaft. This air compressor has a cylinder 5 by 5 in. and was also made by the Union Steam Pump Co. The well, which supplies water for cooling the ammonia gas is 555 ft. deep, ranging in diameter from 10 to 8 in., and contains an 8-in. cylinder. The pump used for drawing the water from this well was made by the Keystone Driller Co., and is of the geared type.

There are 2 air receivers in the engine room each 3 by 10 ft., and are made for 200 lb. pressure. The air pressure used for starting the engine is 100 lb. These receivers are supplied with gages made by the Pennsylvania Boiler Works.

There is but one ammonia compressor in the plant, this being rated for 60 tons refrigeration. It has 2 cylinders 18 by 30 in., with cranks placed 90 deg. apart on the shaft. The compressor being of the vertical type does not occupy much floor space, it has a fly-

wheel 16 ft. in diameter and 34 in. wide, which also serves as a belt wheel.

In addition to the equipment already mentioned there is a 2-hp. Erie City vertical boiler in the engine room, fitted with a gas furnace which carries 30 lb. steam pressure, steam being used in the ice cutters.

The gravity oiling system is employed for lubricating bearings in the engine room, the oil being passed through a White Star Gravity Filter, after going through the bearings, and is pumped to a reservoir which gives a 15-ft. head upon the bearings.

Freezing Room

IN the freezing room are 12 tanks placed in 2 rows, each tank being 13 by 14 by 6 ft. Ammonia expansion coils are placed in these tanks in such a way as to form vertical compartments entirely surrounded by expansion coils, space between pipes being filled with wood blocks. This construction is clearly shown in the illustration, Fig. 2. In each compartment thus formed is placed a can or cell 22.5 in. by 11 in. by 6 ft. open at both ends. The size of each tank is such that it will contain 58 cans.

At the bottom of each row of cells is placed an air pipe, having holes drilled in it, which is used in agitating the water while it is being frozen. Around the edge of the tank at the top is an over-flow pipe which carries the impurities, driven to the surface of the water by the agitating air, off to the filter.

Operation

CITY water after passing through a precooler is used to fill the freezing tank. The ammonia expansion valves are then opened and air is blown through the pipes at the bottom of the tank which keeps the water agitated and the impurities float to the surface of the water in the tank where they are removed by means of

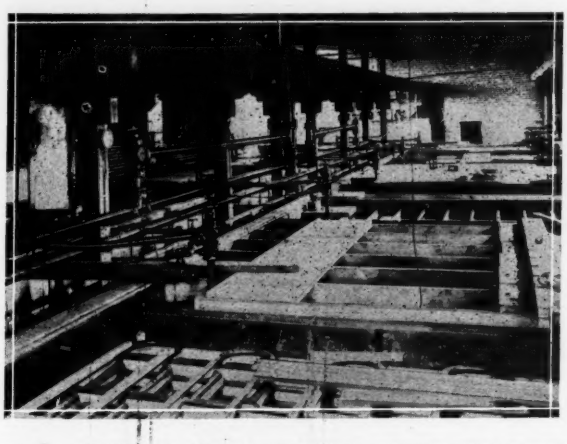


FIG. 2. FREEZING ROOM EMPLOYING BISHOP-CELL-BLOCK SYSTEM

the overflow. This water is then passed through a filter and returned to the freezing tank by means of the circulating pump. When the cells are frozen almost solid, air is shut off and freezing continued a short time, when the tank becomes a solid mass of ice frozen around the coils.

To remove the blocks of ice, hot ammonia gas from the compressor is passed directly through the expansion coils thus loosening the ice from the cells which is then removed by means of the air hoist which hooks into an ice lifter frozen in the top of each block of ice.

These ends are then cut off with steam ice cutters and broken so that the lifter can be taken out and the ice surrounding it is then crushed and used in the precooler shown in Fig. 3. This consists of a metal tank surrounded by a chamber of crushed ice, the height of the water being controlled by a float valve. For crushing the ice used in the precooler, Creasey ice breakers are employed which are operated by a Wagner motor.

Each freezing tank has a special low pressure Ashton ammonia gage attached to the expansion coils

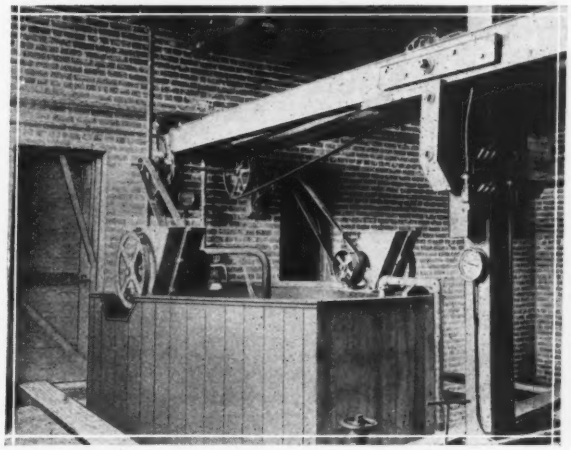


FIG. 3. PRECOOLER AND ICE CRUSHERS

serving as a guide to the operator.

Two gravity filters using quartz as a purifier are employed for removing the impurities from the overflow water as it is being frozen; the surface of the water in these filters is below that in the tanks, and the water is kept in circulation by means of a Kerr Vortex Turbine pump direct connected to the Wagner motor. The blower employed for supplying air to agitate the water in the freezing tank was made by W. S. Rockwell Co.

To prevent liquid ammonia from going to the compressor a device known as an accumulator is employed. This is peculiar to the system, being designed for 18 lb. back pressure and 170 to 180 lb. high pressure.

After the ice has been removed from the cells it is placed in the storage room, which has a capacity of 75 tons and is cooled by direct expansion coils.

The ammonia condenser is placed outside the engine room under a roof and is of the double-pipe type, using well water for cooling purposes.

This system of making ice contains a number of features which reduce the complexity and expense of operating ice manufacturing plants and its success means a great deal to the ice making industry. No brine whatever is employed which is more or less difficult to handle and keep at the proper density, and also keep out of the ice cans. Another distinct advantage is that no steam condensing system is needed, this being an expensive part of the ordinary ice making plant and one which requires great skill to operate to the best advantage.

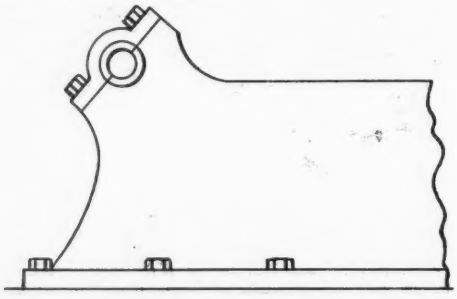
The chief engineer for the Citizen's Ice Co., is Chas. Wallraff, who has had considerable experience in making ice from raw water and he feels perfectly confident of the success of his new plant. The plant was installed by the Great Lakes Engineering Works of Detroit.

Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

Babbitting a Main Bearing

WHAT is the best way to babbitt the main bearing of an engine, the arrangement of the bearing being as shown in the illustration? E. B.



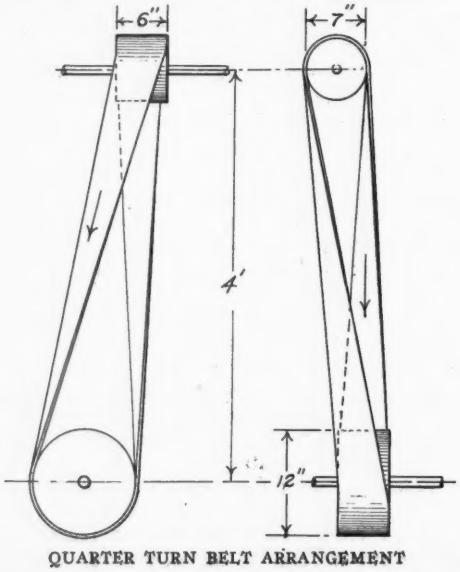
BEARING TO BE BABBITTED

Knock in Pump

I AM having trouble with a knock in our Blake 13 by 9½ by 12 in. pump which works against 350 lb. pressure. It has an air chamber on both suction and discharge and nothing seems to be loose about it, but the knock seems to be in the water end. Can anyone suggest the cause? M. S.

Quarter Turn Belt

IN the plant where I am employed we have a short quarter twist belt that has been giving me an unknown quantity of trouble. The belt runs at high

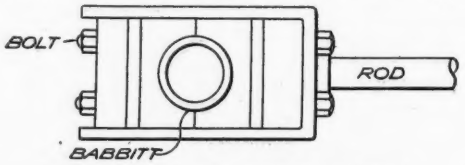


QUARTER TURN BELT ARRANGEMENT

speed with a 7-in. driving pulley to a 12-in. driven pulley; the belt burns out in a few minutes and we have to lace it from 10 to 15 times in a day. Now, we have tried heavy belts and light belts and all proved unsuccessful. I would like some advice from some of the older engineers in regard to stopping the friction and making a lasting and successful job. H. A. C.

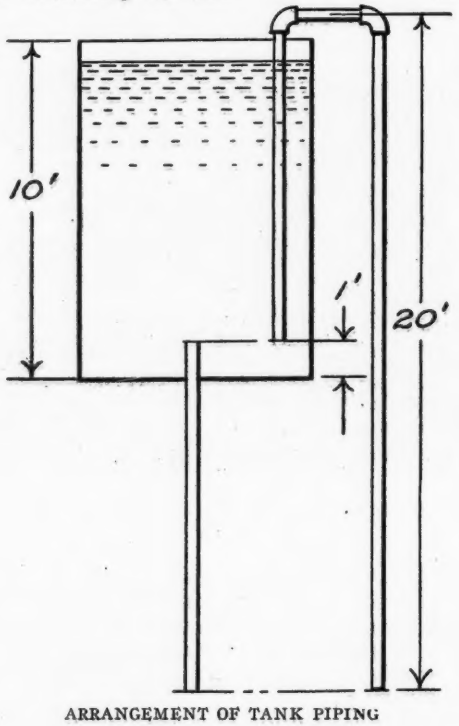
Connecting Rod Trouble

IN the case of the marine end connecting rod shown in the sketch, I am having trouble trying to take out a knock which has developed. I have tried all kinds



CONNECTING ROD WHICH KNOCKS

of liners and it both knocks and gets too hot. This is the rod on an air compressor and has babbitted boxes on the connecting rod end. M. E.



ARRANGEMENT OF TANK PIPING

Flow from a Tank

IN the illustration is a tank 10 ft. deep with a 1-in. pipe over the top reaching within 1 ft. of the bottom. The other pipe is connected through the bot-

tom of the tank and is also 1-in. and extends up in the tank 1 ft. One man claims that neglecting a very small amount of friction, that once the water starts to flow, just as much water will go through the siphon as through the bottom pipe, another claims that the bottom pipe will discharge the most water. Which is right? H. S.

Thrust Bearing Surface

A BOAT and cargo weigh 4500 tons and the speed is to be 12 miles an hour. How large should the surface of a driving bearing be?

A. By driving bearing it is assumed that a thrust bearing is meant and it is first necessary to estimate the power required to drive the vessel at the specified speed. With no definite characteristics of ship given, this can be done only by a general assumption regarding the missing items of information. The rule most commonly used is as follows:

To find the indicated horsepower, square the displacement of the ship in tons and extract the cube root of this square. Multiply that by the cube of the speed in knots or miles per hour and divide by a coefficient which will depend on the unit of speed employed as well as dimensions and shape of the vessel. In the present case we may assume this coefficient as 300 and then applying the rule we find that the horsepower is equal to $273 \times 1728 \div 300 = 1572$. This is the indicated horsepower developed in the cylinders. Of this total amount a fraction estimated at from 65 to 70 per cent represents the power developed by the thrust in propelling the ship. A commonly employed rule is 2/3 of the indicated horsepower as the thrust power. Assuming this value we have 2/3 of 1572= 1048, and this multiplied by 33,000=34,584,000 foot pounds per minute.

At 12 miles an hour the vessel moves 1056 ft. a minute and dividing the foot pounds by the feet per minute we get the actual thrust to be taken care of on the bearing equals $34,584,000 \div 1056 = 32,750$ lb.

The area of the driving surface on a thrust bearing is usually determined by allowing from 40 to 60 lb. per square inch. In the present instance if we take 50 as an average value we shall have the area $= 32,750 \div 50 = 655$ sq. in. W. F. Durand.

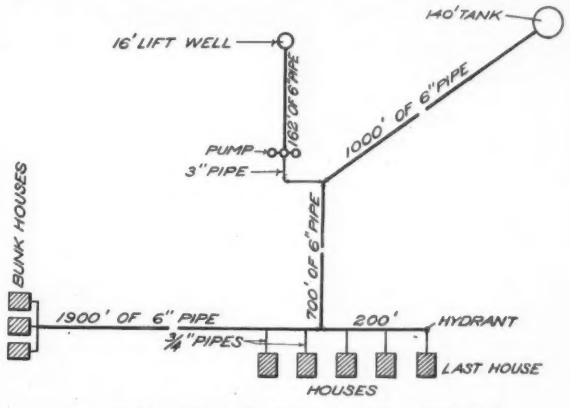
Pipe Rattling

I HAVE a Stillwell-Bierce power motor-driven pump 6 by 8 in. triplex, working on a 16-ft. lift, 162 ft. from the well. The pump forces the water into a tank 1000 ft. away and at about 140 ft. elevation. The pump has a 6-in. suction pipe and 3-in. discharge pipe at the pump, but about 20 ft. away it discharges into 6-in. pipe. The 6-in. line goes to the tank and to 5 houses about 900 ft. and also about 1900 ft. to a boarding house and bunk houses. The leads to the houses are ¾-in. pipe from the 6-in. line. The water pipes in the last house rattle and clatter badly, the man who lives in that house works nights and sleeps daytimes, while the pump is running, and has made a complaint, so we would like to find some way to stop the noise.

The valves are working alright, and all joints are tight around the pump. The accompanying diagram shows the layout. Chas. Sawyer.

A. The rattling of the pipes is no doubt caused by the entrained air, of which there is always certain to be some in the discharge pipe, and especially in the one referred to for the reason that it is so long, and is so much larger than the discharge at the pump.

The air gathers at the dead end of the 6-in. pipe at the last house, and small quantities of it will pass at times into the ¾-in. pipe leading into the house. The space occupied by the air cannot be filled with water until the air is expelled, consequently there is a constant struggle going on between the air and the water



PIPING ARRANGEMENT WHICH RATTLES

for supremacy, both being under pressure, and the result of it all is the poor man is kept awake by the rattling pipe.

By the erection of a 6-in. stand pipe, 18 or 20 ft. high, at, or near the dead end of the 6-in. main, the trouble may be remedied. C. F. Swingle.

Gas Turbine

IN the case of the exhaust turbine for a gas engine, discussed in one of your issues of 1910 how is the air inlet valve to the turbine operated? Is it automatic or mechanical? What is the proportion of this valve to the diameter of the exhaust and for what part of the engine stroke is it kept open? E. H.

A. In reply, I have operated the air inlet valve both ways, automatically and mechanically; with single cylinder or two-cylinder where the clatter of the valve is not objectionable the automatic is the simpler. Much of the clatter can be obviated by making the clapper tight with large area, and opening only, say ⅛ in., but this depends so much on varying conditions, on various engines, that no fixed rule can be laid down.

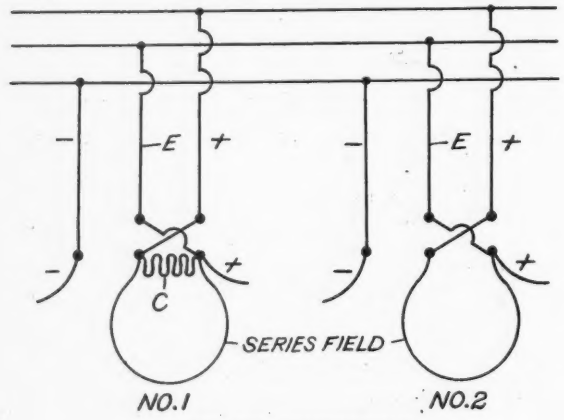
In designing it must always be borne in mind that if the area of the air intake is too small, the vacuum in the exhaust pipe will be relieved over the turbine, nullifying much that is gained by the application of the exhaust to the wheel. Without knowing conditions under which it is proposed to operate, it would be impossible to state intelligently what the proportion of this valve to the exhaust pipe should be. It should, however, open immediately after the exhaust valve. A small poppet valve inserted in the exhaust pipe at its root and operating automatically will immediately show when the vacuum begins to form, and if the exhaust valve is operated mechanically, it should be set to open when this poppet valve opens. Do not attempt with an automatic valve to operate a multiple cylinder engine running at high speed and exhausting through a muffler, for there is always some back pressure which will keep an automatic valve closed.

If this device is not to be used for a muffler as well as a power producer, make all the passages through the wheel liberal as well as the pipe leading to the wheel. If the exhaust is to be carried any distance from the wheel after its passage, use pipe of large diameter; I have found thin spiral wound, galvanized pipe to be good for this purpose as it is light, cheap and durable. Geo. J. Murdock.

Series Shunt on Compound Generator

WILL you kindly tell me the object of having a coil in parallel with the series field of a compound machine? This coil is of German silver, 2 strips ¾ by 1/64 in. each and 5 ft. long are put together and coiled and connected as shown. Machine No. 2 has no such coil.

These machines will not run in parallel, although they are wired to do so, and when the load gets too heavy for one, the other is put on, on separate cir-



GENERATOR CONNECTIONS

cuits, by means of double throw switches. If they are put on to run in parallel No. 2, which is the smaller, takes all the load, leaving No. 1 light.

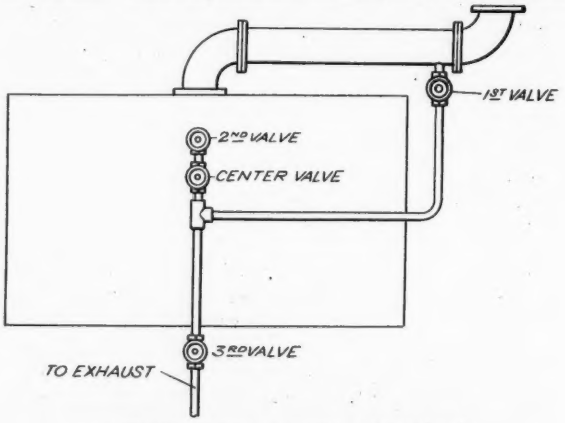
No. 1 regulates rather badly, requiring adjustment of rheostat for almost every change of load. No. 2 is all right in this respect, but picks up and holds its voltage with resistance all in. The speeds of No. 1 and No. 2 are respectively 400 and 450 r.p.m. In the sketch E is the wire leading to equalizer bus bar. No. 2 engine runs better when the steam pressure is about 20 lb. lower than we carry, but as No. 1 needs the higher pressure we cannot reduce it to suit No. 2. Would a reducing valve in the line to No. 2 be advisable? L. R.

A. The strip that you mention in parallel with the series field of your dynamo is what is called the series shunt and is for the purpose of regulating the amount of compounding. Generally the series field is made strong enough so that if all the current from the armature were sent through it the voltage would rise considerably as the load came on.

In order to adjust this compounding the shunt is put on and its resistance is regulated to take more or less of the current, thus making the voltage hold steady as the load comes on or rise in any desired way.

From what you say of the machine it would seem that the shunt is taking too much of the current, so that the compounding does not raise the voltage as it should. In the case of your No. 2 machine, as there is no series shunt, the entire current comes through the compound coil and it raises the voltage accordingly. Apparently from the way the 2 machines act when thrown in parallel, the compounding of the No. 2 machine is higher than that of the No. 1 machine. In this case the resistance of the shunt should be increased so as to let the compounding of No. 1 machine become heavier and that should make No. 1 carry the proper part of this load. If the 2 machines have not the same characteristic, that is, if they do not compound in the same way and about in the same proportion as the load comes on, you cannot make them run in parallel anyway, because even if the load divided properly at one value it would not divide properly at another value.

To increase the resistance of the shunt you can cut down the width of one of the strips or you can take out one of them entirely, leaving only one strip in the shunt. This adjustment should, however, be done



ARRANGEMENT OF PIPES AND VALVES

rather carefully, as otherwise you are liable to get startling results. If possible the experimenting with 2 machines in parallel while you are making the shunt adjustment should be done when the load is very light so that conditions can be readily controlled. Of course, artificial load would have to be used to see how the division of load is working as the shunt adjustment is made.

Piping to Balanced Steam Valve

I AM running a Huston-Stanwood & Gamble engine and as it is of a slide-valve type I have put a ⅝-in. steam pipe running as shown, in the middle of the steam chest. This pipe runs from the main steam pipe to the side of the chest.

The valve of the engine is a common slide valve and it is set with springs making it what they call a balanced valve.

The center valve I open and keep open when the engine is running, it seems to help to keep the valve tight to the seat as the springs are getting weak. I keep the first valve open and just crack open the center valve. The second valve I keep shut as it is over the top of the valve and I put it there to warm the engine when it is cold, and when I do that I keep the third valve closed as it leads to the exhaust, and it works well that way.

Now there is an engineer friend of mine who said if I keep the third valve open while running it will be better; when I do that I have to open the first valve wide open and the center valve wide open. A

great deal of steam goes into the exhaust, and the oil for the cylinder is in the pipe ahead of that connection.

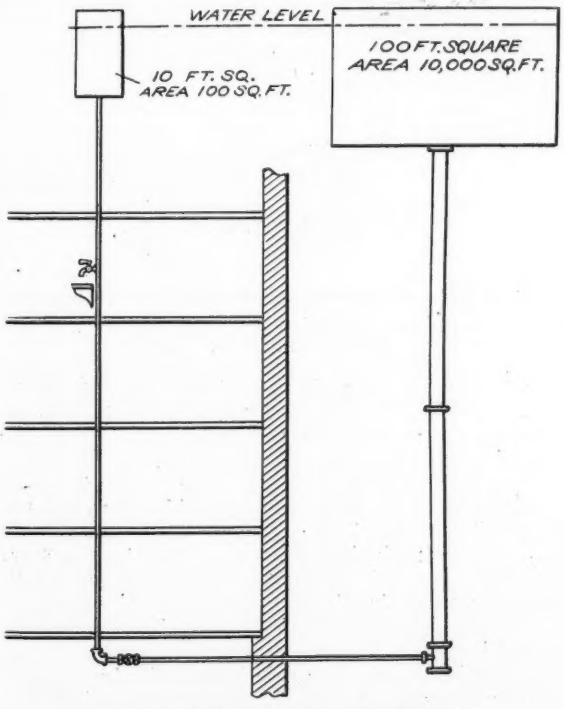
Now, does not the oil go through the pipe into the exhaust that way, and also does not more steam go to waste? I would like to know what you think of this. My friend said if the engine should happen to draw water this method would help. F. P. B.

A. The valve in its balanced form is, of course, supposed to take no steam pressure on the part inside of the balancing plate, and you are simply putting steam pressure there to help hold it against the seat.

The method that you have adopted of operating is by far the better. Opening the third valve under the exhaust simply means that you are blowing steam from the main steam pipe into the exhaust continuously and it serves no purpose and will be likely, as you suggest, to take part of the oil away from the cylinder. Of course, if water came over into the engine this drip might relieve part of it, but probably the greater volume of steam flowing through the main pipe will carry a good deal of water into the engine and what the leader took out would not be of any great help. I should certainly run with the valve to the exhaust closed.

Flow of Water

IN answer to H. M. S.'s query, page 634 of the October issue, I have the following to say: I have watched without a murmur a good many discussions about various topics. Now I would like to



ARRANGEMENT OF TANK AND RESERVOIR

put an oar in and help H. M. S. convince that mechanical engineer, that he is wrong. In a way he is right, but for every gallon of water that comes from the tank, I will show him that just so many more gallons come from the supply pipe as the area of the reservoir is to the area of the tank.

For convenience we will say the tank is 10 ft. square and the reservoir is 100 ft. square. This gives the area of water at surface of tank 10×10=100 sq. ft., and the area of water at surface of reservoir 100×100=10,000 sq. ft.

Now as water tends to keep its level, it ought to be clear that 10,000 parts of water would flow from the reservoir to every 100 parts from the tank, or 10,000 to 100=100 to 1, therefore 100 parts come from the supply pipe to every one part from the tank.

This increases or decreases as the area of the tank is to the area of the reservoir.

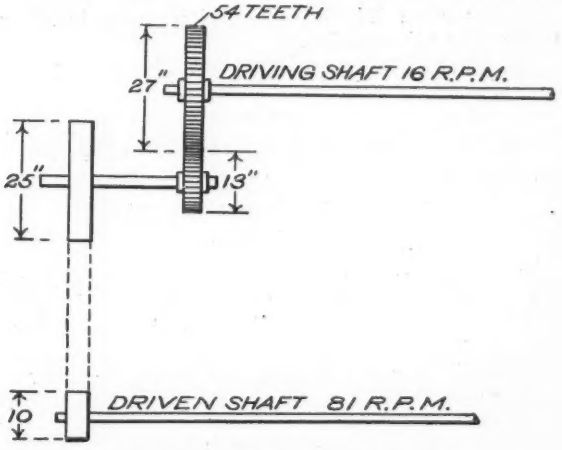
Care of Idle Boiler

TO H. M. S. I would say that you should let your boiler cool down slowly by getting every particle of fire from under it—from ash pit as well. Then after your furnace temperature and the steam pressure have fallen and your steam gage registers 5 or 10 lb. you may now proceed to open your blowoff valve and let the water out.

Let it stand empty until a day before you get ready to put it in commission, then you can fill it up to the water level and be ready to start the next morning. Your idea is alright in regard to having your boiler in readiness, but as you stated you use one boiler one month and then change to the other, there is no need of keeping water in the unused boiler as it is detrimental to boiler plates and tubes. John L. Riggins.

Gear Ratio

IN the accompanying sketch is shown a transmission arrangement in our plant. The main driving shaft runs at 16 r.p.m., it has attached to it at the end a gear wheel with 54 teeth. On the intermediate shaft are a gear wheel and a belt pulley, the latter being 25 in. in diameter. The main driven shaft is to run at 81



ARRANGEMENT OF TRANSMISSION

r.p.m. What size gear wheel and belt pulley should we use for followers? G. G.

A. Your problem is one which might have any number of solutions with the data given. You state that the gear on the driving shaft has 54 teeth, but do not give the pitch diameter or the pitch of the teeth or anything by which the size of the gear can be determined. Neither is the distance between the centers of the driving shaft and the intermediate shaft given. Assuming some values and solving the problem with those, will show the process with whatever figures you may have.

Suppose the gears are No. 2, then the circumferential pitch will be 1.57 in., and to find the pitch diam-

eter we divide 54 by 2, which gives us the diameter, 27. Suppose the distance between centers of the driving shaft and intermediate is 20 in., the diameter of the driven gear will then be found by subtracting from twice this the diameter of the driver: 27 from 40 leaves 13, and this will have 26 teeth because the number of the gear multiplied by the pitch diameter gives the number of teeth.

The speed of the countershaft will then be 16×54 ÷26, or 33.2. Now the problem is to find the size of the pulley on the driven main shaft, and this comes from the regular proportion 81 is to 33.2 as 25 is to the unknown, and the unknown diameter will be 10¼ in.

This is, of course, without any allowance for slip of the belt, and as 2 per cent slip is usually allowed, the diameter of the driven pulley should be made 2 per cent smaller, or the pulley would be practically 10 in. in diameter.

Practical Questions for a State Examination

WHAT is the difference between a tandem engine and a cross compound?

2. Where is a vacuum used in a condensing engine?

3. What are waste cocks placed on an engine for?

4. What is the horsepower of an engine with diameter of piston 10 in., length of stroke 15 in., mean effective pressure 40 lb., revolutions per minute 250?

5. State a simple remedy for keeping water from foaming in a boiler.

6. What does the steam gage show?

7. Describe the operation of a throttle governor automatic cutoff gear.

8. What defects would you look for on an engine that has stood for one year?

9. State in full how you would set the valves on a simple slide valve engine.

10. What is the most important thing to be put on a head between the boiler and engine?

ANSWERS TO EXAMINATION

QUESTIONS FOR MASSACHUSETTS' SECOND-CLASS ENGINEER'S LICENSE

By P. E. Merriam

AN equalizer, or more properly speaking, an equalizer connection, is not necessary for the setting or connecting up of a horizontal return-tubular boiler.

Generally we find an equalizer connection only on heating plant boilers, where the returns from the heating system come back to the boilers by gravity. It is generally the case that although the plant requires more than one boiler, the duties of the boiler room are such that they do not require all the attendant's time, and he has other duties.

As such plants are usually blown down entirely at the end of the heating season, the boilers are run quite a while between openings of the blow-off valve, so the reduction of water in a tight system is very slight, practically caused by the opening of the air valves on the radiators.

Usually when the returns are not piped into the blow-off pipe, it has been found necessary to connect a pipe into the steam space of each boiler to equalize the pressures, and thus prevent the greater portion of the returns from entering one boiler, under certain conditions of operation.

When the returns enter the blow-off pipes, the arrangement is such that the blow-off pipes act as equalizers. This is accomplished as shown in Fig. 1.

Here the main return pipe branches off to each boiler and the stop valve A is open. The blow-off valve is connected into the blow-off pipe leading from the tee B, and is, of course, closed. The returns should divide equally and each boiler receive the same volume of water.

2. Generally the longitudinal joint fails first, although it may be of any one of the various types and the girth seam only single riveted.

This is as it should be, because the pressure tending to burst the girth seam is that perpendicular to any diametral cross-section of the boiler. The pressure tending to disrupt the longitudinal seam is only half the pressure perpendicular to the diameter.

If the boiler is 60 in. diameter and 16 ft. long the stresses on the 2 joints are found thus:

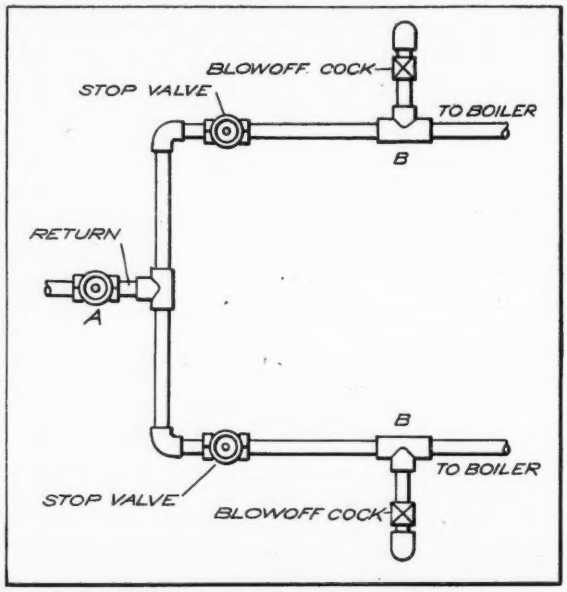


FIG. 1. BOILER EQUALIZER AS RECOMMENDED BY THE MASSACHUSETTS BOARD

The area of the 60-in. head is $60^2 \times 0.7854 = 2827.44$ sq. in., and with a pressure of 80 lb. per sq. in., the total pressure on the girth seam becomes $2827.44 \times 80 = 226{,}195.2$ lb.

As the diameter is 60 in. the circumference is $3.1416 \times 60 = 188.496$ in., which, divided into $226{,}195.2 = 1200$ lb. per inch long of plate.

The longitudinal joint has to carry a load of $60 \times 80 = 2400$ lb. per inch of length, or twice as much as the girth seam sustains.

3. The safe pressure on a flat surface unsupported, would be small, because, if of large diameter, the surface would bulge. One rule is to multiply 1/6 of the tensile strength of the flat plate by its thickness in inches and then divide by the area, multiplied by 0.09.

If we assume the flat head of a boiler flanged to the shell in the manner of the construction of the return tubular boiler, to be 60-in. diameter and 0.5 in. thick, with a tensile strength of 60,000 lb. per square inch, the safe pressure for this head is found as follows:

One-sixth of the T. S., $60{,}000 = 10{,}000$ lb. This times $0.5 = 5000$. The area of the 60-in. head is $60^2 \times$

0.7854=2827.44 sq. in., which multiplied by 0.09=254.47. This divided into 5000=19 lb. per sq. in.

4. In this case no benefit is derived from the safety-valve reducing the pressure so much before closing, when 3 or, at the most, 4 lb. reduction is all good practice calls for.

To make the valve close on a smaller reduction of pressure proceed as follows: On all the standard safety-valves, some small screw or plug like Fig. 2, will be found tapped into the casing, which when removed will give access to the slotted ring B. A screwdriver or other pointed tool may be inserted through the hole in the case so as to engage the slots in the ring B, when the ring can be screwed downward nearer to the valve seat, thus increasing the area of the holes drilled vertically in the flange C. This has

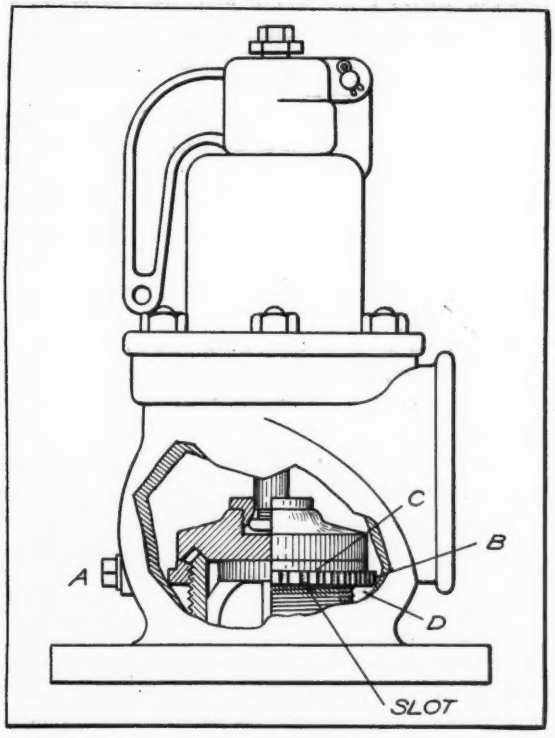


FIG. 2. SECTION OF POP SAFETY VALVE AND BLOW DOWN RING

the effect to slightly increase the discharge of the volume of steam that passes through the small holes in the flange C to the air, and tends to create a slightly lower pressure in the chamber D between the valve disk and the air. This allows the valve to close on a smaller reduction of pressure. Several trials may be necessary before the correct position for the ring can be found, when the screw A should be set up solid.

5. As the commercial springs furnished with safety-valves usually have a range of pressure of about 15 lb. above or below that for which the valve was intended and adjusted to in the factory it would be necessary to obtain a new spring suitable for 60 lb. from the makers because the spring would be free from compression before a blowing point of 60 lb. had been reached and the valve would be blowing through into the air.

6. As the piston on 1 side moves the steam valve on the other, the 5-ported construction makes the simplest arrangement of mechanism and castings. With the usual arrangement of valve gear it is necessary to have the ports like this to obtain compression, since compression in this type of pump is not obtained by the admission of live steam before the piston reaches the end of its stroke, but by the piston trapping a volume of steam between the cylinder head and itself after it passes the exhaust port as in Fig. 3.

7. If the lost motion between the steam valves and the nuts or collars on their stems is increased, the steam valves will remain at rest a longer time, during which the steam piston is moving; the result is that the length of piston stroke has been increased. If the lost motion is reduced, the stroke will be shortened because the piston will move the steam valves earlier in the stroke of the pistons.

8. Answering the last part of this question first, each exhaust valve comes up against a shoulder on the rod and is held there by a washer and nut on other side of the valve. To change compression on 1 end it would be necessary to put washers on the valve rod

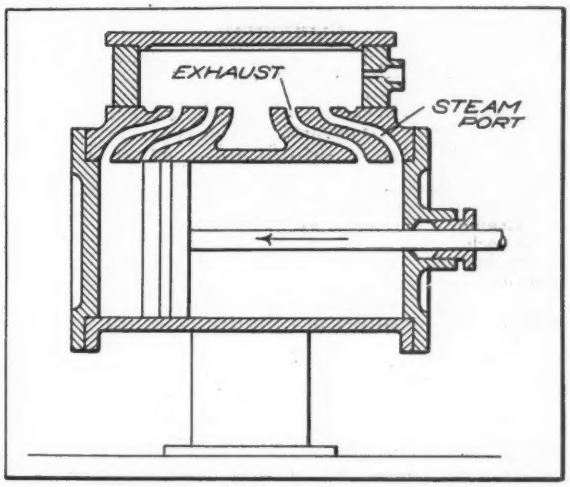


FIG. 3. ARRANGEMENT OF PORTS OF A DUPLEX PUMP

to change the location of the exhaust valve on the exhaust rod according to which way the valve was to be moved.

9. The Fitchburg engine governor is a type of shaft governor, and the centrifugal force of the revolving weights balances the tension of the springs when the engine is running at normal speed.

Should one of the weights come off, the centrifugal force would be reduced, and the result would be similar to increasing the tension on the springs; the speed would increase.

10. If a spring broke, the result would be that a balance between centrifugal force and the tension on the springs would be all destroyed for normal speed, and the speed would decrease, since the weight would have no resistance to overcome. Centrifugal force would be greater than the pull of the springs.

A NEW BOOK by Theo. Audel & Co. called Hawkins' Electrical Dictionary, is just on the market and is a complete reference work for words used in regard to electrical apparatus. It contains 530 pages, 6½ by 8½ in., and is over 1½ in. thick, bound in black cloth with gold edges. Theo. Audel & Co. are offering to send this work, price of which is $3.50, for examination, with return privilege if not found satisfactory.

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SMOKE

Not for its commercial wastefulness, but for its unsanitary unsightliness does the public at large hate smoke. A city does not care on its own account whether the chimneys belch forth carbon monoxide or carbon dioxide or pure nitrogen. But it is much concerned that its Monday wash shall not be sprinkled with carbon nor its Sunday ostrich feathers streaked with grime.

That the manufacturer is led toward more economical conditions by his effort to avoid making smoke is no business of the Health Department or the Aldermen. But smoking is naughty and disagreeable and it does injure the public health, so in most cities, the city fathers are saying, "You must stop that chimney smoking. Once, we fine you; twice we FINE you; three times we shut you down."

That's a nice comfortable position for the city, but somewhat hard on the manufacturer. Be he big or little, he must bear the expense and trouble of finding how to stop smoking. It seems a fairer attitude for the city to say, "We'll do our best to help you stop smoking. We'll tell you what to do and help you find your trouble. Then, if you don't stop, you'll pay the penalty.

That is the attitude which the Chicago Smoke Prevention Department has found it possible and desirable to take, and the result has been great progress in reducing smoke.

One difficulty that has beset the operating force is the regulation of air supply. It is quite generally agreed that the fireman is more of a factor than the furnace in avoiding smoke, but it is quite possible to waste a lot of heat, even from a non-smoking chimney, by over-supply of air; and the problem becomes a nice one to give enough air to complete combustion yet not have an excessive amount so as to make heat.

Watching the chimney top with one eye and the firebox with the other is too strenuous to be long continued, hence, the convenience of a recently patented smoke gage which indicates on a dial the color of the smoke at every instant is evident. Air can be cut down until smoke just doesn't form, and, when fresh fuel is added, the air can be regulated gradually so that no smoke appears, but no heat is wasted. The instantaneous reading feature, similar to that of a steam gage gives the possibility of complete and intelligent control, and makes the demand of the city that the furnace which it has approved be so handled as not to produce smoke, reasonable.

HEATING SURFACE

To get heat into water, heating surface must be furnished. Whether it shall be in feed-water heater, economizer or boiler is a question of how the heat can best be secured.

Feed-water heater surface is limited by the supply of exhaust steam available, and the open type may be found the better for any given case.

For heating beyond this limit, choice must fall between boiler surface and economizer surface. Heat may profitably be extracted from the gases down to the temperature needed to create draft, leaving aside for the present the question of advantage between natural and mechanical draft. Where the division shall occur between economizer surface and boiler surface is a question worthy of careful consideration in each case and is treated at length in an article in this issue.

High furnace temperature such as is necessary for complete combustion, demands a large heating surface, but experiments have shown that effectiveness of boiler surface decreases rapidly as the temperature of gases is reduced. This is with natural circulation; when rapidity of circulation is increased, the effectiveness of heating surface is much greater, and it is evidently easier to hasten circulation in an economizer than in a boiler.

R. S. Hale has deduced from tests recorded by Geo. H. Barnes that, in the boiler, the best results are secured by providing a square foot of heating surface for every 3 lb. of water to be evaporated per hour. The statement of the article mentioned is that the rate of transmission through economizer surface is more rapid than through the part of the boiler heating surface which comes last in contact with the gases. This seems reasonable in view of the greater temperature difference, and the problem in a new installation is, "how far may increase in economizer surface be carried by cutting down boiler surface, and have this advantage remain with the economizer. It would seem that the planning of boiler and economizer must be carried on at the same time and the best division of surface between the 2 carefully determined in order to get the greatest effectiveness from the plant. The economizer thus becomes, not an afterthought or simply an auxiliary for saving heat otherwise lost, but an integral part of the steam making outfit to be considered at the same time as the boiler and with the same care.

DETAILS

Failure often lies in the familiar phrase, "That's a mere detail." A drip pipe and trap where there is a water pocket in a steam line is a detail, but it makes the difference between smooth operation and blown out cylinder heads. The kind of packing in a stuffing-box is a detail, but, oh, what a bother if it isn't right and rightly put in.

And so it goes all down the line. Unless the details are right, the best laid plans will come to wreck. Which has been the cause of such weariness of flesh and spirit in gas engines as well as steam plants—also has greatly increased the crop of unprintable language.

Two articles in this issue especially point these remarks. The first on the relation of accessories to gas engine shut downs (accessories are only a detail. The "main" features of the engine were all right); and the second on gas producers, telling some details which when neglected, have wrought havoc with the industry.

Steam plants suffer just as frequently as gas plants from this cause. The only advantage is that builders and operators have learned what details are likely to make visible trouble when neglected; but others may cause just as big a loss.

The question of conservation of resources, both in material and in human effort is one of detail. For years effort was made to get the valuable products out of sawdust, but with little success. Then a patient experimenter tried a treatment at 145 deg. temperature instead of 175 deg., and the problem was solved.

The lesson for the power plant manager is plain. Until all details are in the best shape, the plant is not right, and there is chance for improvement and saving. That a man has high ideals in his head and a good plan of operation on paper, does not mean that dollars are not blowing out of the exhaust and chimney or running down the sewer—unless the ideals and plan have been worked into masonry and metal with all details carefully completed.

1910 INDEX

The yearly index for 1910 is now ready and will be supplied to anyone desiring it on receipt of postal card request.

On Jan. 23 a meeting of some 200 engineers was held in the rooms of the Western Society of Engineers, Monadnock Bldg., Chicago, to take steps towards organizing a Chicago section of the Institute of Operating Engineers.

F. R. Low of New York, told of the purposes of the Institute and of the work being done in his city, and enthusiastic endorsement of the movement was given by a large number of speakers, among them, C. W. Naylor, Prof. P. B. Woodworth, John C. Moore, J. F. McGrath, Prof. Freude, J. C. Miller, Prof. A. W. Moseley, F. W. Raven, Prof. G. F. Gebhardt, Mr. Fleming, Thomas McNeil and Mr. Eliot.

C. F. Wilson acted as temporary chairman and C. W. Naylor was chosen as permanent chairman. By resolution of the meeting it was voted that the chairman appoint a committee on By-laws and a nominating committee to suggest a list of names for the offices, these committees to report at a meeting to be held at the same place on Feb. 6. All engineers are invited to be present at that meeting. O. Monnett was chosen secretary of the meeting and the chairman of committee on By-laws is J. C. Miller, and of nominating committee, I. J. Babcock.

The Institute of Operating Engineers has secured permanent headquarters in the Engineering Societies' building, 29 W. 39th St., New York. The chairman of the executive committee in charge of organization work is J. C. Jergesen, the secretary M. W. Rice, who may be addressed at the above headquarters. Branches are now in process of formation throughout the country and work has already been adopted in the extension courses of a number of schools and societies, among these the Teachers' College of Columbia University and the Winson Trade School. Renewed interest and a chance for larger activity has been developed by the issuing of a prospectus containing a proposed plan and scope of the work, which can be obtained by writing to headquarters.

PITTSFIELD, MASS., BOILER EXPLOSION

A BIG LOSS OF LIFE, BECAUSE SOMEONE WAS CARELESS

FROM the extent of the damage done, and the distance to which pieces of the boiler and engine were thrown, there can seem to be no question but what this explosion was caused by overpressure. As is usual at the case of an inquest after an explosion, the testimony is conflicting and contradictory, but so far as it goes, and according to tests of the safety valve which have been made, the direct cause seems to have been tampering with the safety valve on the indications of an incorrect pressure gage.

The boiler itself was of such gage and condition that the greatest caution should have been exercised in operating it, particularly as it had been lying idle for practically a year with all the attending possibility of corrosion. Inspection was made last March and certain changes ordered by the inspector, including a new water glass, ¼-in. pipe connection, the removal of a bushing from the discharge of the safety valve, removal of bricks and ashes from the furnace and from the water leg of the boiler on the outside, and the provision of a new safety valve. One report states that these changes were made, and a certificate allowing a pressure not to exceed 70 lb. per sq. in. issued in November or December, but Inspector Forebush states that the safety valve provided was a 3½-in., whereas he ordered a 2-in., and that this valve was set at 80 lb., instead of 70; also that the bushing was not removed from the outlet.

However this may have been, testimony of several witnesses agrees that when the boiler was first started on the day previous, the steam gage acted badly, and the boiler blew off first at 35 lb., and afterward at 70. Trouble had been experienced the year previous with this gage and it was taken to a local shop for testing, and there pronounced O. K. Other testimony stated that on the morning of the explosion the cap to the safety valve had been removed, whereas it was on the valve the day previous, also that an assistant, by orders of the chief, screwed the safety valve down about 4½ turns. Tests of the valve made after the explosion showed that it would not open at 150 lb., or at 160. Later the valve was forced open by water pressure at 225 lb., and later it popped at 220 and afterwards at 200 lb., showing that the spring had been strained beyond the elastic limit, as would necessarily be the case if a spring intended for 80-lb. pressure had been screwed down so that it would hold 200 lb. pressure.

Indications were that there was plenty of water in the boiler as shown by the destructiveness of the explosion, although it was stated that at the time of the explosion water was being pumped into the boiler by hand as the regular feed pump and injector seemed to be out of order. All of the 20 men who were in the boiler room at the time of the explosion were killed, so that there is no direct testimony on this point, the conditions in the boiler room just previous to the explosion being stated by Mr. Shand, who had left the room a few minutes previous. Those who were in and about the boiler room beforehand testified that the needle on the gage jumped from 82 to 140 lb., and this coupled with the fact that the boiler blew off when the gage was registering from 35 to 40 lb., the valve being set for 80, is sufficient evidence that the gage was out of order.

On whom the responsibility of screwing down the safety valve rests probably never will be known. It seems probable that the engineer in charge of the plant

WATER LEG AND CROWN SHEETS

BACK HEAD FROM TUBE SIDE

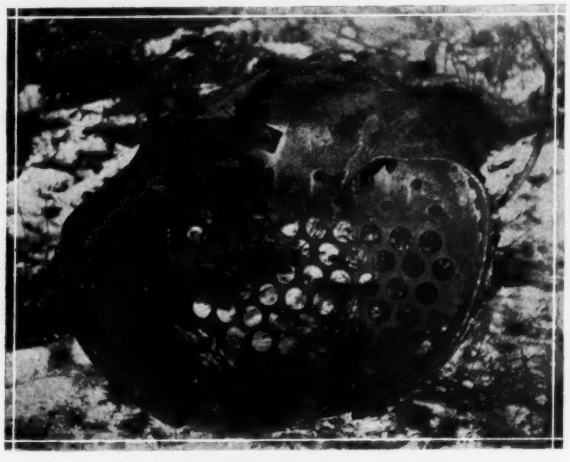
gave the actual order for screwing down, but whether he did this on his own accord, or because of orders issued by his superiors is a question of dispute, and the fact that he stated to his son, before going to work for the day that he was afraid of danger, would seem to indicate that he had been obliged to do something contrary to his best judgment in the handling of the boiler.

The force of the explosion is indicated by the fracture of the plates and the pulling out of stay bolts as

MIDDLE COURSE SHEET

clearly indicated in the illustrations. It is further shown by the fact that the cylinder of the engine was thrown some 600 ft. from the boiler location, that the middle course of the boiler was thrown 500 ft., while other parts were scattered from 50 to 200 ft.

As to the history of the boiler and its condition with regard to a probable explosion, it had been in use



BACK HEAD FROM SMOKE BOX SIDE

for some 40 years in various towns in western Massachusetts and was of locomotive type with barrel 36 in. diameter by 7 ft. long, built of 3/8-in. iron plate in 2 courses. The tubes were 2¼ in. diameter and the stay bolts in the sides of the water legs were 7/8 in., spaced 4 7/8 in. centers. The usual crown bar style of support was used on the crown sheet, and all joints were double riveted. The joint was not in this instance, the cause of failure, as the illustrations show that most of the rupture was through the body of the sheet.

Further information in regard to the findings of the inspector and the coroner's jury will be given in the March issue.

LIFE OF ELECTRICAL APPARATUS

ELECTRICAL apparatus is generally considered to be less rugged than some other classes of machinery, but the following story shows through what severe ordeals it may sometimes pass without serious damage.

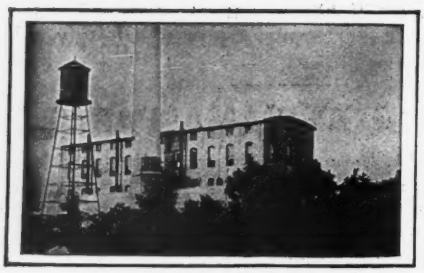
After the explosion and fire which recently destroyed the Los Angeles Times Building, 2 Bullock motors were removed from the basement, where they were lying in 5 ft. of water. The presses to which they were attached were completely destroyed and had no value except as scrap iron. The motors, however, were not badly damaged and were practically the only article of value saved from the ruins. In the adjustment of losses made by the Fire Underwriters' Association, 99 per cent of the total insurance was allowed, the 1 per cent saving being based almost entirely on the value of the motors. The life of the insulation of these was destroyed but the commutators, brush holders, bearings and frames of the machines were in perfect condition.

The motors attracted considerable attention and excited much comment because of the fact that they were the only pieces of machinery saved from the ruins. The larger motor is a 60-h.p., 500-volt, 400-r.p.m. machine, while the smaller is a 10-h.p., 450-r.p.m. They are now being rewound in the shops of the manufacturer, Allis-Chalmers Co., and will be used to drive new presses in the new building which is soon to be erected.

Correction Note

IN our issue of January it was unintentionally stated that the Tuxeda union is made of bronze and iron. This is a mistake, as all 3 pieces of the Tuxeda union are of solid Tuxeda bronze, an alloy especially devised to give soundness and great tensile strength. This union is made by Franklin Williams, of New York City.

ON FEB. 9 the Institute of Operating Engineers will begin a series of monthly meetings in the hall of the Engineering Societies Building, 29 West 39th St., New York City. All individuals and members of societies are invited to attend these meetings, and papers which will be of general interest to the operating engineers throughout the country and proceedings will be printed in full from time to time. The speakers at the first meeting will be Prof. F. H. Sykes and Mr. C. H. A. Bjerregaard. The topic will be Industrial Education, and the speakers are men who have made a life study of the subject, both in this country and in Europe. Willis Lawrence, chairman of the Committee on Vocational Statistics and Cooperation, desires the names of all engineers who contemplate making a change in position, as the committee is having frequent inquiries for men to fill good positions. In writing to him engineers should state present position, compensation and general experience, also whether they wish to remain near the present locality or would prefer to move to some other part of the country. The plan of the committee is to form a national exchange for communication between employers and engineers, and all communications will be held strictly confidential on both sides.



Power Apparatus

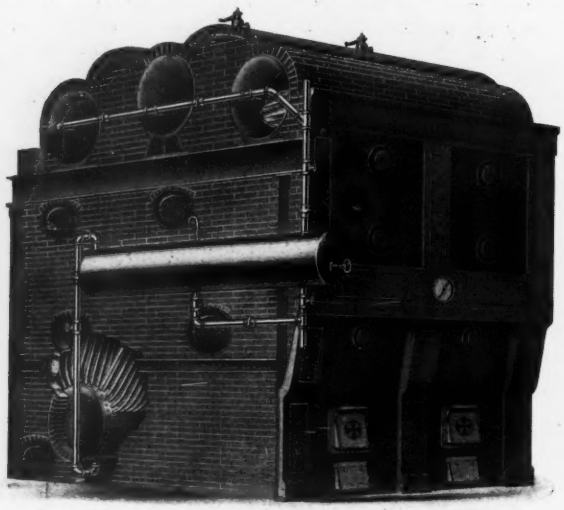
In Shop and Market

New Ideas in Making, Buying and Selling

RAPID FILTRATION

ONE of the fundamental principles upon which the efficiency of the Ray Steam Filter depends is that the rapidity at which chemical reaction, due to treating water with soda ash and lime, takes place, doubles with every 20 deg. increase in temperature. Also, the precipitate caused by this treatment will settle in comparatively still water at the rate of about ½ in. per second. By referring to Table 2, it will be seen that while it takes 7 hr. for complete reaction in water at 60 deg. F., only 24 sec. are required for this in water at 260 deg.

In the case of a horizontal fire-tube boiler, connection is made at the back of the boiler a little below



THE RAY STEAM FILTER

the water line, and another one at the bottom of the boiler at the back, usually through the blow-off. The circulation of the water in the boiler is such that water is caused to flow back into a tank from the top of the boiler and taken back to the bottom of the boiler.

The pipe carrying hot water from the top of the boiler, is connected to a Y into the top of which the feed line is connected by means of a nozzle, so that the feed water will be carried past the opening of the Y and into the tank. This mixing of the feed water with hot water from the boiler is for the purpose of raising the temperature of the feed water sufficiently for rapid chemical reaction and sedimentation.

Where heaters are used, as is generally the case in plants of any size, the piping to and from the boiler is of such size as will induce a flow through the tank of an amount equal to the amount delivered from the feed pump, and the feed water is thus raised to a temperature of from 220 to 260 deg. Table 2 shows that at these temperatures chemical reaction is completed in from 1 min. 38 sec. to 24 sec.

The Hydraulic Press Brick Co. of Kansas City, Mo., has three of these purifiers in use and a boiler pressure of 95 lb. is carried. A heater is used which delivers the water to purifier at only about 186 deg., but this water is delivered to the boiler at 240 deg. temperature. Where no heater is used, a greater volume of water must be taken from the boiler in order to get the feed water up to the proper temperature, and usually the settling tank must be made a little larger to allow the water to remain in it for a longer time.

The proportion in which water from the boiler and the feed water must be mixed depends also upon the temperature of the water in the boiler, hence, the higher the pressure carried the less is the amount of water to be taken from the boiler. As these settling tanks are covered with asbestos and are always located as close as possible to the boiler the radiation is negligible.

TABLE I. TIME WATER WILL REMAIN IN TANK FOR RATE OF FEED SHOWN IN SECOND COLUMN

NO. OF TANK		1	2	3	4	5	6	7	8
SIZE		12"X3'	16"X5'	18"X6'	18"X8'	30"X9'	22"X10	22X12	24"X12'
CAP. GAL.		18	58	79	105	146	197	235	282
BOILER H.P.	GAL. EVP. PER HR.	MIN. SEC.	MIN. SEC.	MIN. SEC.	MIN. SEC.	MIN. SEC.	MIN. SEC.	MIN. SEC.	MIN. SEC.
10	41.25	26:12							
15	61.75	17:30							
25	103.	10:24	29:24	45:36					
50	206.		15: 0	22:48					
75	309.		10:20	15:24	20:24				
100	412.			10:48	15:18				
125	515.			9:10	12:12	17: 0			
150	618.			7:48	10:12	14:12	20: 0		
175	720.			6:42	9: 6	12: 0	16:24	19:36	
200	824.				7:36	10:36	14:18	17: 0	
250	1030.				6: 0	8:12	11:30	13:42	
300	1236.						9:30	11:24	
350	1442.						8: 0	9:47	
400	1648.							8:30	10:12
450	1854.							7:34	9:12
500	2060.							6:48	8:12

Water is delivered to the settling tank about the middle of its diameter and directed toward the end opposite to which it must flow, this end being convex throws the water outward from all sides but a trifle more downward, causing practically a uniform flow toward the other end throughout its entire cross section. The force of this current is at all times at right angles to the force of gravity which tends to draw all foreign matter to the bottom and there is no force except this horizontal current which tends to carry this back into the boiler.

Reagents, usually nothing but soda ash and sometimes lime, are fed into the feed line or the suction line of the pump where they become thoroughly mixed with this water before mixing with the hot water from the boiler, so that chemical reaction is complete almost by the time this water is delivered to the settling tank.

With stationary boilers it is the usual practice to use a settling tank of such a capacity that it will allow the water to remain in it about 5 times as long as is theoretically required for complete reaction and sedimentation. For instance, in the case of a 100-hp. boiler carrying 110 lb. pressure, where a feed-water heater is used the following will ordinarily be the conditions:

Temperature of water in the boiler 344 deg. F.; temperature of feed water from the heater 210; mixing the water from the boiler and the feed water in equal quantities will give a resultant temperature of about 277 deg., this being ½ the sum of these 2 temperatures as the total amount of heat units in equal quantities of water is almost in proportion to their temperatures. Allowing 10 deg. for radiation the water will be delivered to the boiler at 267 deg. Assuming that this temperature has fallen only about 7 deg., or is a temperature of 270 deg. when entering

TABLE II. TIME FOR COMPLETE CHEMICAL REACTION WITH SODA ASH TREATMENT

TEMP. F. DEG.	TIME OF REACTION			TEMP. F. DEG.	TIME OF REACTION		
	HR.	MIN.	SEC.		HR.	MIN.	SEC.
60	7			200	3	16	
80	3	30		220	1	38	
100	1	45		240		49	
120		53	30	260		24	
140		26	15	280		12	
160		13	7	300		6	
180		6	33				

the tank, chemical reaction will have been completed in about 18 sec. The water is introduced at about the middle of the tank's diameter, but we assume, for a factor of safety, that it will have to settle the full diameter of tank used.

A 100-hp. boiler, according to the ordinary rating, would evaporate 412 gal. of water per hour, and this is the rate at which it must be fed, and as an equal quantity is taken from the boiler, 824 gal. per hour must flow through the settling tank. By referring to Table 1 you will note that No. 3 tank, 18 in. in diameter by 6 ft. long, holds 79 gal. and will allow the water to remain in it 10 min. 48 sec. when fed at the rate of 412 gal. per hour, or 5 min. 24 sec. when fed at the rate of 824 gal. an hour.

Assuming that the foreign matter has to settle, 18 in., 36 sec. would be required for sedimentation. Adding to this 16 sec. which we figured it required for chemical reaction, it is seen that theoretically only 52 sec. is required at this temperature for complete reaction and sedimentation. Practice has determined that these figures are correct. It will be seen at once that all suspended matter will settle readily in the tank.

The Wisconsin Zinc Co., Plattesville, Wis., is using water from its mines to feed the boilers through these purifiers, and is running them as long as 7 weeks without a shut down, while before the purifiers were used the plant shut down once every week and as much as 3 wheelbarrow loads of sediment taken from each boiler.

At the Hydraulic Press Brick Co. installation, referred to above, water is taken from the Blue River, and in a recent flood when the water was very muddy they ran their boilers for 7 weeks, feeding them with this water direct from the river unfiltered, except by means of these purifiers. When opened the boilers were found clean. At this plant it has always been the practice to weigh all coal used and reports from their engineer show that the use of these purifiers has reduced the amount of coal used by 15 per cent.

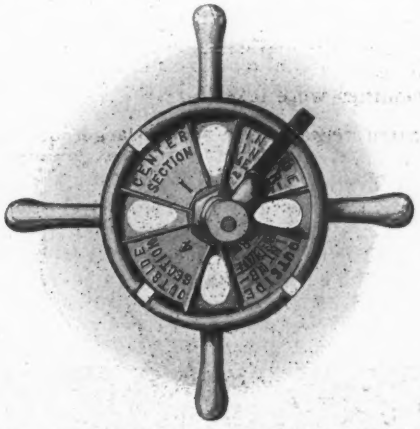
Chemical analysis is always made and the proper reagent recommended. As about all the temporary hardness is removed due to heat alone at 212 deg. very little reagent is required for this. In cases where a permanent hardness is so high as to make an almost saturated solution, a good bit less reagent is required for this treatment than with the cold water treatment, due to the fact that water will hold less sulphates and chlorides of calcium, magnesium and iron at a high than at a low temperature.

Removal of sediment is accomplished by closing both valves connecting the purifier to the boiler and opening the blowoff, at the same time drawing sediment toward the blowoff by means of the scraper, handle of which shows at the end of the bank. Ordinarily this is necessary only once or twice a day. Scraper is returned to its position, blowoff closed and the other valves opened when the purifier is again in operation.

Oil, which will rise to the top of the purifier, is blown off through the top vent before the blowoff is opened.

TUBE BLOWING CONTROL

THE illustration shows the hand control wheel of the New Marion Flue Blower, which indicates at all times the exact operation of the blower. In operating this hand wheel, start with the valve spring lever in notch No. 1 on the hand wheel and turn the hand wheel around slowly 2 or 3 times and



HAND CONTROL WHEEL OF NEW MARION FLUE BLOWER

as the indicator shows, it will clean the center section of the tubes of the boiler and at all times the steam action of the blower will follow the spring indicator on the lever.

After cleaning the center section of the tubes then move the spring lever to section No. 2 and revolve the hand wheel slowly 3 or 4 times, which will clean the inside intermediate section of the tubes of the boiler.

After this is done move the spring lever to notch No. 3; do not turn the hand wheel entirely around but see-saw the hand wheel backward and forward on the right-hand and left-hand side of the operator, which will clean the inside intermediate tubes of the boiler.

Then move the lever to notch No. 4 and see-saw the hand wheel on the right-hand and left-hand side of the operator, the same as when the lever was in notch 3, which will clean the outside tubes of the boiler.

By watching the indicator on the hand wheel, it will become apparent to the operator that, in cleaning the outside intermediate and outside tubes, as the distance to the nozzle of the blower is further from the outside tubes of the boiler than it is from the center tubes, the reason for not turning the hand wheel entirely around in cleaning the outside intermediate and outside tubes of the boiler, is that it would cause the steam to play against the arch of the boiler, which is entirely unnecessary, if the engineer will follow the indicator of the blower.

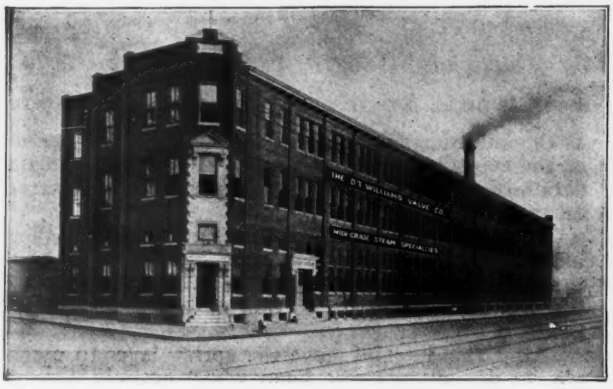
Also, in following the instructions as shown by the indicator, it will eliminate, to a great measure, the amount of soot that is blown into the boiler room in operating the blower, which has been a great objection in some instances in operating rear end blowers.

By operating this blower as shown by the indicator, the steam, at all times, is playing only on the tubes of the boiler and, in conjunction with the heavy natural draft, caused by the operation of the blower, all of this soot will be drawn out through the chimney, thus keeping the boiler room, to a marked degree, free from soot.

D. T. WILLIAMS VALVE CO.'S NEW QUARTERS

THE D. T. WILLIAMS VALVE CO. was organized and entered into the manufacture of high grade valves, lubricators and steam specialties in 1904, and has one standard of quality, the very best it could possibly produce. The business has grown continuously and even during the depression of 1907 showed a substantial increase month by month until about a year ago, the facilities were taxed to their utmost capacity and it became necessary to secure larger quarters to take care of the requirements of the fast growing business.

The illustration shows the new building located at Spring Grove avenue and Township street, with facilities that are 4 or 5 times greater than the old one. There is a modern and complete brass foundry which will occupy the entire third floor. In connection with this there will be a large number of new lathes, drill presses, automatic machines of all kinds, and a complete and elaborate testing outfit, on which all of Williams products are tested, and which constantly insures uniform quality of product.



NEW PLANT OF THE D. T. WILLIAMS VALVE CO.

D. M. Forker, formerly one of the executives of the Republic Iron & Steel Co. of Youngstown, O., has purchased an interest in this company, and with his wide acquaintance among the large manufacturing interests throughout the country, will be of valuable assistance. The officers of the company are now as follows: D. T. Williams, president; D. M. Forker vice-president; R. E. Mullane, treasurer; F. L. Swanberg, secretary.

In response to calls for gate valves and other standard specialties the Williams Co. is now at work on patterns for gate valves, whistles, lubricators, and will add a number of new specialties to its line.

FIG. 1. BOILERS AND STOKERS IN THE BAXTER LAUNDRY

STOKING THAT PAID

AMONG those who study the sources of loss in power plants it is admitted that careless stoking can cause more waste than almost any other one thing about a plant, and that the wages of an extra good stoker are more than saved by the decreased cost in fuel, but extra good, animated stokers are scarce, hence it is worth while to make note of a mechanical stoker which has proved its right to be classed with the money savers.

FIG. 2. EQUIPMENT OF IRONING MACHINE, ONE USE FOR WHICH STEAM IS FURNISHED

In the plant of the Baxter Laundry at Grand Rapids, Mich., are installed Scotch marine boilers, as shown

in Fig. 1. The boiler to the left was first equipped with a stoker in February, 1907, and made a record as follows: It is a 150-hp. unit and when hand-fired, using Pittsburg lump coal at $3.15 a ton, the coal used in 9 months was 1231 tons at a total cost of $3839.30. For 9 months following the installation of the Jones Underfeed stoker, burning Michigan slack at $2.40 a ton, 1130 tons were used, costing $2703.32, a saving of 101 tons of coal and of $1175.98. It was estimated that the load carried under the new conditions was enough heavier

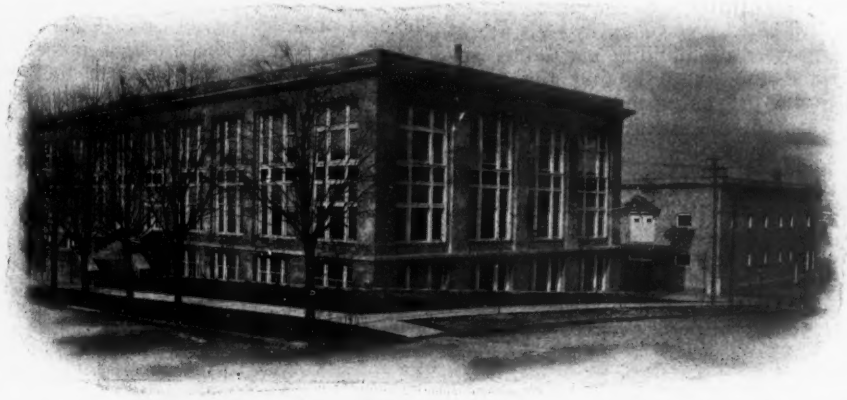


FIG. 3. EXTERIOR OF THE BAXTER LAUNDRY

than that under the old conditions so that the saving, allowing for this increase of load, was $1369.94, making the stoker pay for itself in 9 months.

This laundry is at the corner of Fountain and Northeast streets, in Grand Rapids, and is one of the best equipped in the United States. Its owners aimed to furnish in it conditions which shall be wholesome and pleasant and to enlist the co-operation of employes. Among the comforts provided are a spacious lunch room where coffee is served free to all employes, large and light working rooms with machinery installed to save hard work at all points, and a system of ventilation which keeps the air in the rooms always fresh.

The power plant is located in a separate building at the rear, all machinery in the laundry building proper being driven by individual and group motors.

A STRONG COMBINATION

ONE of the strongest connections of kindred industries recently effected is the joining hands of the Ingersoll-Rand Co. and the A. S. Cameron Steam Pump Works. The former has purchased a controlling interest in the latter, but the 2 companies will be run under separate management as in the past, Mr. Geo. W. Fuller remaining in charge of the Cameron works; no change in policy of that company is contemplated, although a greater expansion is in view. By this move the Ingersoll-Rand Co. adds to its supremacy in the field of air compressors, rock drills and mining machinery, the steam pump in a design which is well known and highly esteemed the world over.

Each of these companies had origin at nearly the same time and in the same building about half a century ago, and for a number of years in their early history the manufacture of both kinds of apparatus was carried on under the same roof, Second Ave. and E. 22nd St., New York. The friendly relationship has been kept up, the Ingersoll-Rand Co. acting as representative for sale of Cameron pumps in some of the leading cities at home and abroad, chiefly in the southwestern territory of the United States and in South Africa. Also for many years the Cameron works made castings for the Ingersoll compressors, and this continued up to the time when the Ingersoll-Rand Co. removed from the city to build its own foundry.

Ingersoll-Rand apparatus is the development of an American invention, the first practical patent for a percussion rock drill having been taken out by J. J. Couch of Philadelphia in 1849. He was assisted in building this drill by Joseph W. Fowle, their experiments being carried on during 1848. Later they separated, and Fowle, in the absence of means to carry on his experiments, remained in obscurity until 1866 when Charles Burleigh purchased the patent and produced the Burleigh drill, which was used in the Hoosac tunnel in 1867. Development along this line was continued by Haupt, De Volson Wood and Simon Ingersoll, and following these came Sergeant, Waring and Githens who was the inventor of the Rand drill.

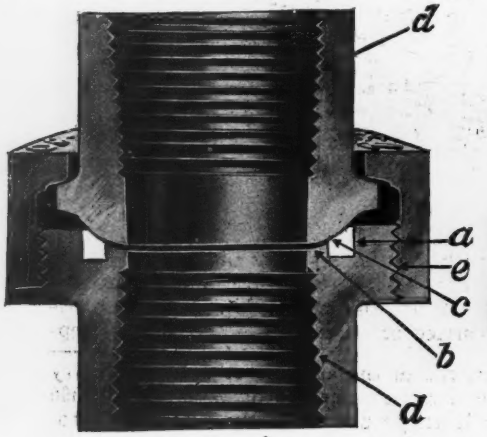
In 1871 came the Ingersoll drill, the inventor of which came to New York from Connecticut and built models of several machines with his own hands. The first rock drill was made from his drawings in the shop at the corner of Second Ave. and E. 22nd St., operated at that time under the management of Sergeant & Cullingworth. Mr. Sergeant devised the method of making the drill in 2 parts, separating the front end from the cylinder of the drill, and later he induced Mr. Navarro, the owner of the shop to purchase all of the Ingersoll rights and patents and the Ingersoll Rock Drill Co. was organized. Mr. Navarro and Mr. Sergeant later became separated from the company, and after a trip west Mr. Sergeant returned to New York and started the Sergeant Drill Co. in 1885.

Back in 1871 there had been started the manufacture of the Rand drill by the Rand & Waring Drill & Compressor Co., later controlled by Mr. Rand and merged into the Rand Drill Co., which was incorporated in 1879. Among these companies the Sergeant & Cullingworth Co., the Sergeant Drill Co. and the Ingersoll Rock Drill Co. were merged into the Ingersoll-Sergeant Drill Co. and later on the Rand Co. was added, forming the Ingersoll-Rand Co., thus joining the valuable patents in rock drills owned by all of these concerns.

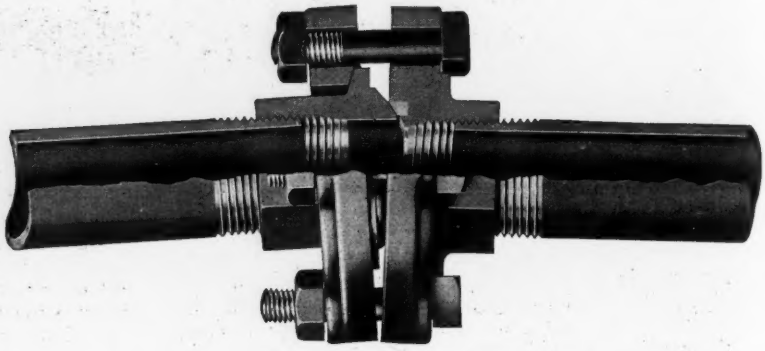
In the history of the A. S. Cameron Steam Pump Works there is not the same tremendous activity and growth as in the larger company, but it is nevertheless interesting. The founder was Adam Scott Cameron, the youngest of 4 brothers and the genius of the family. He served apprenticeship and studied evenings at Cooper Union in New York City, and after graduating with honors engaged in building the Sewell & Cameron crank and flywheel pump, which was used by the navy and merchant marine during the Civil War.

At the close of the war the call for these pumps fell off somewhat, and Mr. Cameron turned his attention to a pump of greater adaptability and wider application, and created the pump having the acorn shaped air chamber, the oak being the emblem of the Clan Cameron. Through his integrity, ability, and force of character he won a leading position in the commercial and financial world for himself which was unfortunately cut short by his death at an early age. Since his death and until the recent change in ownership the business has been carried on successfully by Mrs. Cameron. Of late years, however, the growth has been retarded by the location of the plant in New York City, which did not allow of adequate expansion. This will soon be overcome, for it is the intention to move out of town to more commodious quarters and provide every facility for increased output. George Ward Fuller has been for many years associated with the Cameron Works first as office manager and since 1899 as general manager.

During his management the business has grown rapidly, also the name, title and characteristic emblem have been copyrighted and trade marked, securing the exclusive right to the use of the acorn as a trade mark and to the headline so familiar in their advertising and literature, "The Slogan of the Cameron: Character the Grandest Thing."



SECTIONAL VIEW OF THE JEFFERSON UNION


JEFFERSON FLANGED UNION

JEFFERSON UNIONS

THE principle involved in their construction is to have a metal to metal seat which will be non-corrosive, which will be ductile and at the same time strong, and which will have a considerable range for making tight joints when it is necessary to make connection between pipes which are not exactly in line.

In general, there are 3 types of unions manufactured by the Jefferson Union Co., namely, the plain Jefferson union, the gasketless Jefferson flange union and the Jefferson swing union. These 3 styles, however, are manufactured in a number of different forms each, and it is furthermore possible to utilize a combination of a plain union and a swing union part, which enables the user to manipulate them for a great variety of purposes.

Following is the description of the Jefferson brass to iron seat. Embedded in a channel cut in the concave part of the seat is a small brass ring of wrought metal, cut from seamless tubing, which makes a noncorrosive joint. The Jefferson ring is just large enough to make a tight joint, and is protected from the fluid and securely held in place by a wall of malleable iron, the metal of which the rest of the fitting is made. This wall, which is a patented feature, protects the ring from injury when the pipe is screwed in. It also makes the ring practically one piece with the iron, so that it cannot become dislodged. The embedded brass ring is cut to fit the convex spherical end of the opposing member and the 2 parts are ground to a perfect fit, so that it's easy to make a tight joint even if the pipes are not in perfect alinement.

In the case of the flanged union, it is possible to make connections between 2 pipes which are as much as 5 deg. out of alinement and still have a perfectly tight and solid joint, as shown by the accompanying cut. The absence of a gasket and the loose collar are the distinguishing features of the flanged union. It is obvious that much time can be saved when using a flange coupling if there is no gasket to be cut and fitted and if no "drifting" is necessary to bring the bolt holes in line. In this union particularly, the spherical ground seat is of especial advantage because as the union is drawn up, the pressure on the seat is always normal, thus precluding any tendency to warp or twist any parts of the union out of shape.

The style of union shown here successfully holds pressures up to 300 lb. For pressures above this the Jefferson Co. has 2 heavier fittings known as the heavy weight union and the extra heavy weight union, which are heavily bolted and guaranteed to stand a working pressure of 3000 lb. per square inch. All styles are made of malleable iron.

The Swing union consists of 2 45-deg. elbows with a spherically ground seat, joined by a nut and so designed that the ends can be attached to the pipes to be connected and the nut then screwed up without interference. It is made of malleable iron, and the regular swing union has an iron-to-iron seat, but at slightly additional cost the regular Jefferson brass-to-iron seat can be furnished. The spherical seat makes it possible to secure a perfectly tight joint for any of the great variety of connections which can be made with this union, and

using one end of the swing union 45-deg. elbows in conjunction with an end of one of the many other Jefferson unions increases the number of possible connections so that it is virtually a universal union.

The swing union is equipped with the same nut that is used on the regular Jefferson union, or furnished with a special nut notched for setting up with a hammer in close work, the nuts being made of either malleable iron or brass.

CORRECTION NOTE

IN the table for expansion of pipes, page 69 of the January issue, at the temperature of 625 degrees for copper and brass, the increase in length above 100 feet should be 9.62 instead of 8.62. We are under obligation to W. Morris, of Louisville, Ky., for calling our attention to this error in figures.

NEWS NOTES

IN CONSIDERATION of the great work that it is doing for the young men of New England and particularly of Massachusetts, and of the burden which it is bearing, something like $176,000 annually, in the expense of educating students from Massachusetts alone, the request of the Massachusetts Institute of Technology for an appropriation of $100,000 yearly from the state seems reasonable and fair. The service rendered is not only to the student themselves but to the industries into which they go and to which they apply the training and knowledge gained from the courses. It is certainly to be hoped that the request will be granted.

THE DEARBORN DRUG & CHEMICAL WORKS, which has distributed its feed water treatment and lubricants through an agency in the Philippines for the past 2 yr., has decided to open its own branch office and warehouse in Manila, and F. O. Smolt, who has been connected with mining propositions since his graduation in chemistry from the University of Illinois in the Class of '91, has become connected with the Dearborn Company, and sailed on Jan. 7 for Manila, to take charge of this work, under the supervision of E. C. Brown, manager of the Foreign Department of the Dearborn Company. Mr. Brown has spent most of the past 2 yr. in Japan, China and the Philippines, investigating steam plant and railroad conditions in the interests of Dearborn products, and is still there, having made selling connections at Tokyo, Tientsin, Hongkong, and Shanghai.

SINCE THE FIRST of January the Best Mfg. Co. has been located in its new plant at Oakmont, Pa., a suburb of Pittsburg. The postoffice and telegraph address will still be Pittsburg, but the freight and express address will be Verona, Pa. The new plant increases the capacity more than double; the concentration of departments, the modern equipment and the excellent facilities for handling will enable this company to render the best possible service as to materials, workmanship and prompt shipments. The iron foundry is newly equipped throughout with the latest improved apparatus, including a complete line of power molding machines, ranging from small squeezers to the largest jarring machines and adapted for all classes of work. The capacity is 90 tons per day with facilities for handling castings weighing 50 tons each.

FOR THE FEBRUARY competition in the Worcester Association No. 4 N. A. S. E., the subject will be the Corliss Valve and Valve Gear. Papers are now being considered by the committee.

THE AMERICAN SOCIETY of Engineer Draftsmen, at 116 Nassau St., New York, has been formed for the purpose of advancing engineering knowledge and practice, maintaining a high professional standing among draftsmen, the holding of meetings for reading and discussion of professional papers, maintenance of an engineering library and of an employment bureau for the benefit of members and for furnishing data in regard to various drafting rooms throughout the world. Local branches may be organized in any locality where there are 15 members. Further information can be had by writing to Henry L. Sloan, Secretary-Treasurer, at the above address.

THE CEMENT AGE, 30 Church St., New York, announces its purchase of Concrete Engineering, formerly published at Cleveland, Ohio. The combined magazines will be known as "Cement Age, with which is combined Concrete Engineering," and will be published from the New York office. Robt. W. Lesley will be editor of the combined paper, and Allen Brett, formerly editor of Concrete Engineering, will take a position as associate editor of the new publication, Edward A. Trego remaining also as associate editor. Frederick F. Lincoln will continue in charge of the New York office at 30 Church st., and Arthur E. Warner will become western manager of the combined papers.

ON SATURDAY, JAN. 21 the Engineers' Blue Room Club, of Boston, held its annual Ladies' Night and installation of officers. A musical and literary program was carried out and the following new officers were installed for the year 1911, Geo. W. Knowlton acting as installing officer and Herbert E. Stone as marshal: President, Wm. W. Webb; vice president, Herbert A. Stevens; secretary, Chas. A. G. Winther; treasurer, Thos. B. Constant; sergeant at arms, J. Frank Cochrane; executive committee, J. M. Merrill, A. H. Parker, T. M. Kimball, G. W. Furbush and Herbert E. Stone. The entertainment was in the hands of Frank P. Gardner, Harry H. Atkinson and Chas. B. Klingemann. Three hundred and seventy-five were served at dinner.

ROBB ENGINEERING CO., LTD., has purchased the Robb-Mumford Boiler Works, at South Framingham, Mass., and will continue those works under the present management and manufacturing organization.

CATALOG NOTES

THOSE INTERESTED in the handling of materials, either coal, ore or dirt, will find information and valuable material in The Labor Saver, a bulletin recently published by the Stephens-Adamson Mfg. Co., of Aurora, Ill. It shows a number of conveying plants installed by this company, used in connection with coal washeries, steam shovels and ore piles.

A CONVENIENT REFERENCE index of the products of a concern is often found handy, and the Elliott Co., of Pittsburg, has furnished such an index for engineers to use. It lists and illustrates Elliott Steam Traps, Liberty Feed Water Regulators, Elliott Reducing Valves, Faber Blow-off Valves, Cyclone Tube Cleaners, Bull Dog Tube Cleaners, Elliott Oil Turbines, Oil Separators, Horizontal Steam Separator, Vertical Steam Separator, Single Strainer, Twin and Triple Strainers, Multiple and Intake strainers, the Pittsburg Feed Water Heater & Purifier, and the Pittsburg combined feed water heater, purifier and receiver.

FOR 1911 THE International Harvester Co. of America has gotten out a set of very attractive calendars, directing attention to the well known lines of harvesting machines—Champion, Deering, McCormick, Milwaukee, Osborne and Plano. These calendars are beautifully lithographed in colors and are 20 by 13 2/5 in. in size. The scenes depicted on these calendars include The Hunting Camp, with the successful rifleman who is bringing in a deer; The Days of '49, when the prairie schooner was a familiar sight west of the Missouri River; The Prospectors, in search of the elusive gold; Grandmother Sewing on a Button; The Children Playing with Tige on the Beach, and The Summer Girl with Her Parasol.

Any one of these calendars would be a decidedly appropriate ornament for the home, and can be obtained by a call on your local dealer and asking him for an I. H. C. calendar.

ECONOMICAL FIRE ROOM METHODS, by F. R. Low, is the title of an interesting Bulletin, No. 187, issued by the B. F. Sturtevant Co., of Hyde Park, Mass. This describes a system of stoking boilers at the Wood Mill of the American Woolen Co., in Lawrence, Mass., where remarkable results have been obtained both as to the temperature at which gases are sent to the stack, the small amount of air used in burning the coal, and the high efficiency obtained. The plant is equipped with mechanical draft and Sturtevant economizers, and the methods that have been devised for operating by Capt. Geo. H. Diman, the consulting engineer in charge of the plant, are such as to get the very best possible results out of the equipment. The story of the operation is told in interesting form and complete results of evaporative tests are given.

FROM THE INGERSOLL-RAND CO., of 11 Broadway, New York, have been received new bulletins as follows: Form No. 3007, which deals with the latest design in Power Driven Air Compressors, the principal features of which are enclosed dust-proof construction, automatic flood lubrication for the main bearings, crankpins and crossheads, enclosed wearing surfaces, large valve areas, great intercooler surface and a water separator and clearance controller, all of which are clearly described in the bulletin. Form No. 5003 describes the Radialaxe air-driven coal cutter which is a machine designed for undercutting a pitching seam in coal mining work, also for shearing, for mining, in the middle of a seam, and for cutting out bends of coal. It is a long stroke drill mounted so that it is especially adapted for the classes of work mentioned, the work which it can do, its construction and the details of operation being fully illustrated and described in the bulletin. Form 9008 describes pneumatic tamping machines for relining copper converters. These are built on the same general principle as the Ingersoll-Rand Co.'s rock drills, with modifications to meet the requirements of the special work. The device is arranged to be slung from an overhead crane or chain block and the small machines will do the work of from 6 to 10 men in tamping in the linings, while the larger sizes have nearly 3 times this capacity. The air consumption is small considering the work done.

BULLETIN 130 OF THE Bristol Co., Waterbury, Conn., is a complete description of the Bristol Indicating and Recording Electric Pyrometers and their uses. The different parts of the apparatus are shown, the methods of installing for different uses, such as measuring the temperature in furnaces, in metal baths, in crucibles and in metallurgical operations. Full illustration is given of the different types made, with full size drawing of the scales and charts which are provided. Details are also shown of a special system which includes both indicating and recording instruments. The bulletin may be had by writing to the Bristol Co., at the above address.

WASHING AND COKING TESTS OF COAL made at the fuel testing plant in Denver are described in Bulletin 5 of the Department of the Interior, Bureau of Mines. These tests were made largely to determine the suitability of the coals tested for making coke for metallurgical work and also to determine the percentage of valuable material taken away in the process of washing. The coals tested were from Colorado, Washington, Montana, New Mexico, Wyoming and Illinois, and showed that certain coals from the Illinois field, also some from the Kansas field, are suitable for coking when subjected to the right kind of treatment. The Illinois coals can make coke suitable for metallurgical work, while the Kansas coals produce coke suitable for zinc smelting, which is one of the state's large industries. Some of the Colorado coals could not be coked, others could be coked after washing. Copies of the bulletin may be obtained free by writing to Jos. A. Holmes, Director, Bureau of Mines, Washington, D. C.

WAINWRIGHT WATER HEATERS AND EXPANSION JOINTS is the subject of Catalog No. 14 issued by the Alberger Condenser Co., of 140 Cedar St., New York. This shows the effect of high velocity in heater tubes, in increasing the transfer of heat, also the advantage of the corrugated tube surface over the plain tube. The details of construction of the Wainwright feed water heater in using corrugated tubes is shown, also methods of arranging these heaters and proper methods of piping up. The heaters are made for hot water service as well as for steam service and are arranged where desired for use in connection with a hot water heating system for buildings. In any of the hot water service an automatic control is provided which will keep the temperature of the outgoing water constant. Construction of the expansion joints and of anchors and guides for use in piping are also shown, these joints and anchors being suitable for either high pressure or low pressure piping systems. Brief mention is made at the end of the catalog of the Alberger condensers in barometric, centrifugal and surface form, also of Alberger cooling towers and turbine pumps. The catalog is attractively arranged and full of useful information.

FROM THE LIBERTY MFG. CO., PITTSBURG, PA., comes Bulletin No. 70, describing a combined tube cutter and expander for cutting and expanding boiler tubes. This is furnished in either plain or ratchet form, and may be had with an extension wrench for operating the expander or cutter in the smoke box end of a boiler or other places where it is unhandy for the operator to get at the work.

BULLETIN 182 of the B. F. Sturtevant Co., Hyde Park, Mass., describes the new horizontal center crank engines, Class HC-1, showing the general type of these engines and also explaining and illustrating details of construction. This engine is of the high speed single valve type for direct connection to fans, electric generators and other similar machinery, has sensitive inertia governor, balanced piston valves, gravity lubrication and other up-to-date features. For special work it may also be made with a throttling

governor where desired. The bulletin gives full description of the engine and dimensions of the different sizes.

A GENERATION OF PROGRESS IN PUMPS is the title of an attractive booklet recently issued by the Deming Co., and showing the progress of its product from 30 years ago to now. It tells of the uses of Deming pumps for mines and mills, for waterworks, for factories, for irrigation purposes, and for farm and home. The different types of pumps used for these different services are attractively illustrated. The pamphlet can be had from the Deming Co., Salem, Ohio.

FROM THE GREEN ENGINEERING CO. comes a catalog of the Geco Pneumatic Ash Handling Systems, which illustrates the convenience and cleanliness of this system of taking care of part of the unpleasant work in a boiler room. To operate this requires only one man and it is put in service by turning on power and a spray of water. The spray operates so that the ash may be handled directly from the furnace pits dry and hot, but are automatically quenched and cooled before depositing in the tanks. The full details of the system, and also facts in regard to cost of operation of the system, are given in the catalog, which is in such attractive form that one reads it for pleasure as well as for information.

FROM THE ALLIS-CHALMERS CO., Milwaukee, comes Bulletin 1501 describing the Allis-Chalmers Reliance Belted Corliss Engine and giving full details in regard to the construction and manufacture of these engines. All details are illustrated and a full table of sizes and capacities is given.

FROM THE WESTINGHOUSE DEPARTMENT OF PUBLICITY comes the Westinghouse 1911 Diary, a most convenient book of information in regard to electrical apparatus, compressed air, steam and gas engines, chain drives, stokers, hydraulic machinery, steam turbines and switch and signal apparatus. Beside this special technical information there is a complete diary for the year 1911, calendars for 1911 and 1912, and miscellaneous information which is of use in daily life. It is of convenient vest pocket size and in substantial leather binding and will be valued by everyone who is fortunate enough to receive it.

THE OHIO BLOWER COMPANY have recently published a miniature catalog in which is briefly described all the Swartwout patented products. These include the well-known Swartwout Cast Iron Exhaust Heads, Centrifugal Steam and Oil Separators of various types, the Swartwout Automatic Safety Water Gage and the new Rotary Ball-Bearing Ventilators which have just recently been placed on the market. These catalogs are very handy for ready reference and will be sent on request by The Ohio Blower Company, Cleveland, Ohio.

THE GENERAL ELECTRIC CO. has recently issued bulletins as follows:

Bulletin 4782 entitled "Direct Current Exciter Panels," illustrates and describes exciter panels for use in connection with alternating current generator panels when for any reason separate control of the exciter is desired. The bulletin contains a complete description of these panels, also diagram of connections and dimensions.

A new edition of the bulletin entitled "Automatic Voltage Regulators for Direct Current Generators" has just been issued. The number is 4602-B.

A booklet describing "Miniature Decorative Incandescent Lamps" illustrates lamps in color, and various designs representing fruits and flowers are shown. These lamps are used for decorating Christmas trees and also in connection with set pieces of artificial shrubs, trees, etc. The number of the booklet is B-3004.

SMOOTH-ON MFG. CO. of Jersey City, N. J., has recently prepared a booklet showing the use of Smooth-On Protective Paints for iron and steel. The Smooth-On cements are well established for making repairs on iron and steel, and users have requested an iron paint. In response to these requests the Smooth-On Co. has worked out during the past 3 years a metal covering which will be sold as Smooth-On Iron Paint and which the company is willing to stamp with its label. A booklet showing the uses of this paint and the effects which it produces in changing a rough, pitted surface to a smooth one, also the efficiency in the protection of surfaces from pitting, will be sent to any one sending his name and address to the company.

FROM THE STRONG CARLISLE & HAMMOND CO. of Cleveland, O., comes its Catalog No. 14, describing the strong steam saving and protective devices. It is an especially well prepared and printed book with cuts that clearly show the parts of all devices and descriptions that explain their operation. Fine paper and careful printing make the catalog an attractive addition to an engineer's collection. It can be had by writing to the company.

TRADE NOTES

NELSON VALVE CO. is sending out a unique piece of advertising literature and one which engineers will find helpful and interesting. This is an accident preventer which was suggested by an accident in a

boiler plant that fatally scalded the fireman. It is a "Hands Off" sign to prevent monkeying with a steam valve which is for the time being out of service or which should be let alone. These danger signs can be had for the asking from the Nelson Valve Co., Chestnut Hill, Philadelphia, and every engineer will readily think of a number of places where he can readily use them to advantage.

MOUND TOOL & SCRAPER CO., 7th and Hickory Sts., St. Louis, Mo., is placing on the market a new device, the Mound Packing Irons for replacing packing in the stuffing boxes of engines, pumps, etc.

These tools are so designed that they help place the packing quickly and accurately in place yet will not cut the rod or packing. They are forged tool steel, nickel plated and polished, come in 4 lengths, for different lengths of box. As regularly made they are 7, 9, 11 and 14 in. in length, but special sizes can be made to order at short notice.

ALBERGER CONDENSER CO., announces that although the contract recently closed with the United States Department covers 11 54-in. and 7 15-in. vertical shaft centrifugal pumps, with complete electrical equipment, for the dry docks at New York, Puget Sound and Pearl Harbor, yet this will not in any way overtax its facilities and regular orders of business will be taken care of promptly.

PROPER LUBRICATION OF ANY bearings, even the ordinary babbitted boxes, is always important, but where roller or ball bearings are used the very life and efficiency of the bearings themselves depend largely upon the lubricant used. The Royersford Foundry and Machine Co., of Royersford, Pa., manufacturer of the Sells Roller Bearings, has brought out a lubricant of its own which is especially adapted to meet the unusual requirement of bearing lubrication. "Rollerine" is the name adopted for this special bearing lubricant, and the company states that during the years in which it has been tested out in actual practice, Rollerine accomplished more than any lubricant previously obtainable. Anyone writing to the Royersford Foundry and Machine Co., at its Philadelphia office, 52 N. 5th St., can obtain full information on what this bearing lubricant has done.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED—By young man 25 years of age, as oiler or work around a power plant, permanent position desired. Reference. Address Box 482, Highland Park, Ill. 2-1

POSITION WANTED—By young man 21 years of age as hoisting engineer or as stationary engineer in small plant. West preferred. W. F. Judkins, Bow, Mich. 2-1

POSITION WANTED—As stationary engineer steam or gasoline engines. Can do own repair work and am machinist and run D. C. dynamos. Have Minnesota license. Moral habits. Address J. L., R. No. 3, Box 39, Fairfax, Minn. 2-1

POSITION WANTED—Engineer would like to take charge of small plant or act as assistant in large one. Have had 7 years' experience. Familiar with the operation of both A. C. and D. C. generators. W. Break, River Rouge, Mich. 2-1

POSITION WANTED—By erecting engineer experienced in installing heating and ventilating machinery and small power plants, open for engagement about Feb. 1st. Reference from former and present employers. Address Box 159, Practical Engineer, Chicago, Ill. 2-1

Help Wanted

WANTED—SALESMEN CALLING on power plants, where belting is used, to sell guaranteed Pulley Wheel Facing. The Non-Slip Company, 150 C, Nassau St., New York. 2-1

WANTED—AN ENGINEER IN each town of Kentucky, Tennessee, Ohio and Indiana to handle a full line of packings. Strictly commission proposition. Anchor Packing Co., No. 34, St. Paul Bldg., Cincinnati, Ohio. 2-1

WE HAVE a stunning proposition for an engineer in every town or city. Little time required. Will not interfere with regular work. Write for particulars. Address Box 136, Practical Engineer. 8-tf

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

Wanted

AGENCIES REQUIRED—AN old established manufacturing firm in London, with a splendid connection among the English and Colonial Railways, is open to make arrangements to manufacture and sell, or to accept an agency for, any really good article likely to be extensively used by railway companies. References would be furnished and required. Communicate to T. N. 310, care T. B. Browne's Advertising Offices, 163 Queen Victoria Street, London, E. C., England. 12-3

For Sale

FOR SALE—17 H. P. GAS or gasoline engine. Fairbanks-Morse make. Self starter. Address Michigan City Paper Box Co., Michigan City, Ind. 2-1

FOR SALE—ELECTRIC LIGHT PLANT in northern Illinois town. Doing good paying business. Reasonable price. Address Box 160, Practical Engineer, Chicago. 2-1

FOR SALE—1 BOGUE 100 AMPERE, 5 volt, Plating generator with rheostat. In first-class condition. 1 small power lathe, 6 in. swing 24 in. bed. H. C. Davidson, 129 Bourbon St., New Orleans, La. 2-1

FOR SALE—ONE D. C. 220 VOLT 35 K.W. Western Electric Dynamo, speed 1150. One marble switchboard complete, with ammeter volt and rheostat with two circuit cables to connect same to dynamo. 1100 ft. No. 000 wire, 750 ft. No. 0—wire, weather proof, good insulation, all in good running order. Write for prices to Pierce Milling Co., Pierce, Neb. 1-3

Patents and Patent Attorneys

PATENTS—Guide Books with 100 Mechanical Movements. Perpetual motions book. 50 illustrations. Mailed free. F. C. Dieterich & Co., Patent Lawyers, Washington, D. C. 2-2

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. 10-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the inventors. Handbook for inventors sent upon request, 186 McGill Building, Washington, D. C. 4-tf

Miscellaneous

EVERY ENGINEER should know about the new system of Vacuum Heating, which can be installed without payment of royalty. Particulars will be cheerfully furnished. T. L. Reeder, 1413 W. Jackson Blvd, Chicago.